Training Report
on
Cultural Heritage Protection

Training Course on Cultural Heritage Protection in Asia-Pacific Region 2004 – China –

12 November－22 December 2004, Tsukuba, Nara

Cultural Heritage Protection Cooperation Office,
Asia/Pacific Cultural Centre for UNESCO (ACCU)

Edited and Published by
Cultural Heritage Protection Cooperation Office,
Asia / Pacific Cultural Centre for UNESCO (ACCU)

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Printed by Shintosha

Preface

The Cultural Heritage Protection Cooperation Office, Asia / Pacific Cultural Center for UNESCO was established in Nara in 1999 with the cooperation of the Agency for Cultural Affairs, Nara Prefecture and Nara City. Since its establishment, the ACCU Nara Office has worked towards the protection and investigation of cultural properties through training courses, international conferences, and database production. Public symposia have also been held with the aim of spreading information about cultural properties to the general public.

Training courses on the investigation and protection of cultural heritage form an important part of our activities. These training courses are of two types: group courses of about one month for some 15 participants and individual training on particular topics for one or two participants. The present course was of the second type and we were pleased to welcome two specialists from China. As is well known, China has some 30 World Heritage sites including both cultural and natural localities. Because these sites are distributed throughout a huge country, each region of China requites its own appropriate methods of site management.

The impressive interiors of the temples in Hohhot, Inner Mongolia and in the Xinjiang Uighur Autonomous Region have been subject to progressive exfoliation and decay and require emergency protective measures. In view of this, we invited researchers actually involved in the protection and restoration of these sites for a training course on the preservation of mural paintings. The course involved not just the study of scientific methods of preservation and repair in departments of conservation science, but also a diverse range of topics including traditional methods of preservation and repair, the utilization of heritage sites in Japan, environmental concerns, and recent research in Japan on Chinese mural paintings. We hope that the topics studied by the participants during the 40-day course will be put to good use after their return to China.

Finally we wish to thank the University of Tsukuba, the Gango-ji Institute for Research of Cultural Properties, Office of the Shosoin Treasure House Imperial Household Agency, Nara University, and the Archaeological Institute of Kashihara, Nara Prefecture for their assistance with this training course.

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1. General Information

Training Course on Cultural Heritage Protection
in Asia-Pacific Region
(12 November－22 December 2004, Tsukuba and Nara)

1. Organizers

Organizers: The Asia/Pacific Cultural Centre for UNESCO (ACCU)
The National Research Institute for Cultural Properties
In cooperation with: University of Tsukuba
Sponsored by: Bunkacho (Agency for Cultural Affairs, Japan)

2. Background

In China, there are 30 World Heritage sites including both natural and cultural properties, in total, as of 2004. These are distributed all over the wide national territory, especially in the southeast plain area along Yellow River and Yantze River, which has had advanced civilization from ancient times. However, located in the westernmost area, famous Dunhuang Mogao Caves and Potala Palace of Lhasa are in the desert with different climate conditions from other areas.

Even in the western region, a frontier area, the industrial development such as oil drilling or the maintenance of traffic network has rapidly advanced in recent years. At the same time, the protection and utilization of natural and cultural properties as a part of resources have attracted attention. However, due to the geographical condition that it is in the remote area, researchers related with protection of such cultural properties, in particular, young researchers in charge of practical work are in short supply in the western region. In addition, under the harsh climate conditions, there are various kinds of difficulties to face. For example, the technological development and the selection of methods, which are necessary for protection, cannot be done properly. Technology transfer for protection and fostering researchers are considered to be an urgent issue.

With such a background, trainees will be invited from Xinjiang Uighur and Inner Mongolia Autonomous Region, and training especially on conservation science necessary for preservation and repair of cultural properties will be implemented, for the purpose of fostering personnel dealing with protection and restoration of cultural heritages in the western region of China.

3. Date and Venues

Date: 12 November to 22 December, 2004

Venues: University of Tsukuba; National Research Institute for Cultural Properties; Cultural Heritage Protection Cooperation Office, ACCU (ACCU Nara Office); Nara University; Archaeological Institute of Kashihara, Nara Prefecture, etc.

4. Objective of the Training Course

Among cultural properties, Buddhist ruins inside caves in the desert area are taken as a main subject. In the training, knowledge of conservation science needed to protect and restore them will be mastered, and various kinds of conservation processing technology and practical works such as selecting materials used for it will be learned as well as the method of maintenance and management with environmental observation.

While conservation science widely contributes to various areas, a main subject is specialized in "murals" this time. This is because trainees to participate in are scheduled to work on restoring and conserving murals in caves and temples in Xinjiang Uighur Autonomous Region and Inner Mongolia Autonomous Region. Therefore, the training is aimed to prepare for the execution of immediate, important and urgent duties.

5. Training Curriculum

Fundamental of conservation science
Conservation science for cave cultural heritages
Conservation of stone remains
Conservation science for stone cultural properties
Method to conserve stone architectures
Conservation and restoration science (techniques)
Conservation and restoration science (materials)
Conservation and restoration science for ruins
Conservation of ancient mural painting and its environment
Monitoring of cave ruins
Analytical instrument and its application
Method of environmental measurement

6. Participants

<u>Wang Qi (王 琦)</u>: Chief Researcher, Culutural Heritage Bureau of Xinjiang Uighur Autonomous Region

<u>Du Xiaoli（杜 暁黎）</u>: Deputy Director, Hohhot Museum, Inner Mongolia Autonomous Region

Others (Past achievement to accept trainees)
Since 2000 when the above-mentioned invitation program started, 11 trainees from 7 countries have been accepted. It is third time to invite trainees from China, following 2000 and 2002.

7. Certificate

Each trainee will be awarded a certificate upon the completion of the course.

8. Language

Chinese will be used throughout the course.

9. Expenses

Expenses for participants in the training course shall be borne by the ACCU as described in the following:

(1) Travel expenses:

Participants shall be provided an economy-class return air ticket between the international airport nearest to their residences and Kansai International Airport / Narita International Airport, and domestic transportation costs / to and from the airports and between the training venues in Japan.

(2) Living expenses:

Participants shall be provided a daily subsistence allowance during the training course, beginning from November 11 (Thu.) to 23 (Thu.) December 2004. Arrangements for accommodations will be made by ACCU Nara Office.

10. Correspondence

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2. Programme Schedule

Day			Lecture	Venue
	11	Thu.	Arrival	
	12	Fri.	Training Course Orientation	ACCU
	13	Sat.		
	14	Sun.	Move from Nara to Tsukuba	
	15	Mon	Orientation at Tsukuba University	
	16	Tue.	History and Conservation of Japanese Architecture Introduction to the Cultural Heritage Protection System in Japan	Tsukuba Univ.
	17	Wed	Materials for Conservation Science	Tsukuba Univ.
	18	Thu.	On-site Lecture: History and Conservation of Eastern Asian Art	Tsukuba Univ.
	19	Fri.	Conservation of Stone Architecture	Tsukuba Univ.
	20	Sat.		
	21	Sun.		
	22	Mon .	On-site Lecture: Conservation and Restoration of Historical Sites	Tsukuba Univ.
	23	Tue.		
	24	Wed	Introduction to Conservation Science Ⅰ	Tsukuba Univ.
	25	Thu.	On-site Lecture: Restoration of Garden Scenery	Tsukuba Univ.
	26	Fri.	Conservation Science Ⅰ	Tsukuba Univ.
	27	Sat.		
	28	Sun.		
	29	Mon	Application of Computer for Archaeological Study	Tsukuba Univ.
	30	Tue.	Conservation Science Ⅱ	Tsukuba Univ.
	1	Wed	Closing Session of the Tsukuba Lectures	Tsukuba Univ.
	2	Thu.	Move from Tsukuba to Nara	Tsukuba Univ.
	3	Fri.	Facility for Conservation Science Ⅰ: Gangoji Institute for Research of Cultural Property	
	4	Sat.		
	5	Sun.		
	6	Mon	Introduction to Conservation Science Ⅱ	NRICPN
	7	Tue.	Workshop: Film Removal Method for Soil Layers	NRICPN
	8	Wed .	Roll of Conservation Science Workshop: Removal Method for Fragile Artifacts	NRICPN
	9	Thu.	Conservation of Wall Paintings Ⅰ On-site Lecture: Conservation of Paper and Silk Paintings	NRICPN

	10	Fri.	Conservation of Wall Paintings Ⅱ Analysis of Materials	NRICPN Shosoin
	11	Sat.		
	12	Sun.		
	13	Mon .	Effects of Air Pollution on Cultural Properties Ⅰ Workshop: Collecting Sample	Nara Univ.
	14	Tue.	Effects of Air Pollution on Cultural Properties Ⅱ Workshop: Analyzing Method for Collected Samples	Nara Univ.
	15	Wed .	Effects of Air Pollution on Cultural Properties Ⅲ Evaluation of the Results	Nara Univ.
	16	Thu.	On-site Lecture: Museum Management On-site Lecture: Excavation of Palace Site	AIK
	17	Fri.	Facility for Conservation Science Ⅱ: Archaeological Institute of Kashihara	AIK
	18	Sat.		
	19	Sun.		
	20	Mon	Computer Reconstruction of the Bezeklik Wall Painting	Ryukoku Univ.
	21	Tue.	Report Writing	ACCU
	22	Wed .	Report Writing Closing Ceremony	ACCU
	23	Thu.	Departure	

NRICPN: National Research Institute for Cultural Properties

AIK: Archaeological Institute of Kashihara

Summary of Lectures

Nov.12 (Fri.)

Training Course Orientation

- Met with Prof. Nishiyama, Nara University and received general information about his lecture.
- Visited the National Research Institute for Cultural Properties, Nara and attended a lecture for the Training Course on the Preservation and Restoration of Cultural Heritage in the Asia-Pacific Region 2004 —Archaeological Research Methodology and Analytical Methods of Ancient Remains—
- Short lecture about the Heijo Palace Site.

(Traveled from Nara to Tsukuba on November 14th)

Nov.15 (Mon.)

Orientation

- Orientation for the lectures at Tsukuba University.
- Visited laboratory for Conservation Science.

Nov.16 (Tue.)

History and Conservation of Japanese Architecture (Prof. Saito, *Tsukuba University*)

- Lecture covered the history of Japanese Architecture from the Jomon Period to the Modern Period.
    - Shinto shrine, temple, aristocrats' residences, vernacular houses, castles etc.
- Based on Study of Katsura Rikyu Villa by Prof. Saito, conservation work for the villa was explained.
- Surroundings of the UNESCO World Heritage Site: example of Shirakawa-go Village.
    - Historical and geographical background of Shirakawa-go.
    - Architectural characteristics of the village.
    - Discussion of the buffer zone surrounding the village.
    - The problem of tourism at Shirakawa-go.

Orientation at Tsukuba University.

Introduction to the Cultural Heritage Protection System in Japan (Prof. Saito, *Tsukuba University*)

- Lecture on the following topics:
    - The meaning of *shuri* and *shukei*.
    - Tangible Cultural Properties and Intangible Cultural Properties.
    - Districts for Groups of Historic Buildings
    - Folk Cultural Properties.

Prof. Saito's lecture

Nov.17 (Wed.)

Attending Dr. Matsui's lecture.

Materials for Conservation Science (Dr. Matsui, *Tsukuba University*)

- How should we be involved in the conservation of cultural properties.
- Important philosophy on conservation science and the restoration of cultural properties.
- Conservation methods for architecture in Turfan.

Nov.18 (Thu.)

On-site Lecture: History and Conservation of Eastern Asian Art (Prof. Sawada and Prof. Yagi, *Tsukuba University*)

- Visited the Tokyo National Museum.
    - The special exhibition "Treasures of Ancient China" was currently on display.
    - Discussion on methods for displaying museum collections.

Lecture by Prof. Hidaka.

Nov.19 (Fri.)

Conservation of Stone Architecture (Prof. Hidaka, *Tsukuba University*)

- Structural dynamics of brick buildings: how to build architectural features.
- Important points for restoration and conservation of brick buildings.
- Discussion of the kinds of materials used for joints of bricks.
- International situations that influence the conservation of cultural properties.
- Architecture techniques of the Renaissance and Baroque periods
- Problems with applying for UNESCO World Heritage status: how UNESCO World Heritage sites are registered.

Nov.22 (Mon.)

On-site Lecture: Conservation and Restoration of Historical Sites (Prof. Sawada and Dr. Matsui, *Tsukuba University*)

- Visited the Hirasawa *Kanga* Site to view reconstructed archaeological sites: specifically, the regional governmental office during the Nara period.
- Site lecture: purpose, history and management of archaeological and heritage sites.
- Study of examples of restoration, reconstruction, and utilization of features and archaeological sites.

- Visited and viewed collections in the administration building and museum for unearthed artifacts from the Hirasawa Kanga Site.

Reconstructed buildings at the Hirasawa *Kanga* Site.

Lecture by Prof. Sawada at the Hirasawa *Kanga* Site.

At the Hirasawa *Kanga* Site Museum.

<u>**Nov.24 (Wed.)**</u>

Introduction to Conservation Science Ⅰ (Prof. Sawada and Dr. Matsui, *Tsukuba University*)

- Information exchange about the Otani Expedition to the Silk Road.
- History of conservation science in Japan.
- Methods for conservation science and non-destructive analysis.

<u>**Nov.25 (Thu.)**</u>

On-site Lecture: Restoration of Garden Scenery (Prof. Kuroda and Dr. Matsui, *Tsukuba University*)

- Visited Hama-rikyu Villa garden, Tokyo.
- Restoration and utilization of gardens: problems of management of the historical gardens.
- Requirements and needs for maintaining the scenery and surrounding environment of the garden from modern land development.

Hamarikyu Villa garden, now surrounded by tall buildings.

<u>**Nov. 26 (Fri.)**</u>

Conservation Science Ⅰ (Dr. Matsui, *Tsukuba University*)

- Examples of the removal method.
- Applying the method to various materials: features, footprints, fragile artifacts, and bones.
- How to choose chemicals for removal methods depending on humidity and temperature.
- The current status of conservation science in Japan.

<u>**Nov. 29 (Mon.)**</u>

Application of Computers for Archaeological Study (Dr. Matsui, *Tsukuba University*)

- Visited the CAD Centre, Tokyo.
- Explanation of the facilities and machines was given by the Centres staff.
- Discussed the possibilities of using computers for research in the participants institute in China.

At the CAD Centre, Tokyo.

<u>Nov. 30 (Tue.)</u>

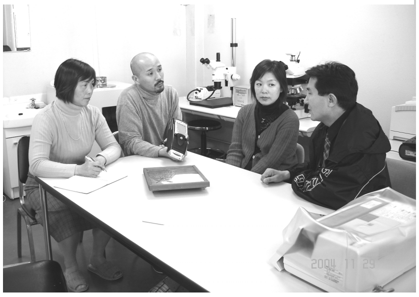
Conservation Science Ⅱ (Dr. Matsui, *Tsukuba University*)

- Lecture on conservation science.
- What kinds of machines are used for conservation science?

<u>Dec. 1 (Wed.)</u>

Closing Session of the Tsukuba lectures (Prof. Sawada and Dr. Matsui, *Tsukuba University*)

(Traveled from Tsukuba back to Nara)



<u>Dec. 3 (Fri.)</u>

Facility for Conservation Science Ⅰ (Mr. Yamauchi and Ms. Yoshimura, *Gangoji Institute for Research of Cultural Property*)

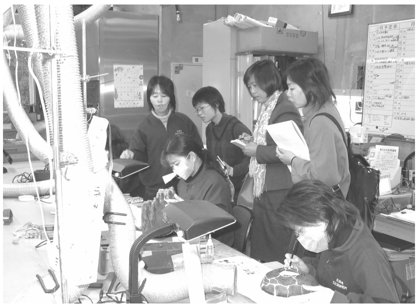
- Visited the Gangoji Institute for Research of Cultural Property to see an example of conservation work done by a private institute. Participants visited the laboratories to see the following processes:
  - Restoration and reconstruction of pottery.
  - Conservation of waterlogged wooden artifacts using the PEG method.
  - Conservation of metallic artifacts.


Lecture on machinery used for conservation work.

<u>Dec. 6 (Mon.)</u>

Introduction to Conservation Science Ⅱ (Dr. Koezuka, Dr. Khozuma, *NRICPN*)

- General information about the National Research Institute for Cultural Properties, Nara.


At the Gangoji Institute for Research of Cultural Property: repairing wooden artifacts.

- How to remove fragile artifacts and features from sites.
- Advanced lecture on the film removal method for soil layers.
- Conservation study of wall paintings—example from the Kitora Tumulus—
- Pigment change from paintings — example of the Takamatsuzuka Tumulus—


Lecture by Dr. Koezuka.

<u>Dec. 7 (Tue.)</u>

Workshop: Film Removal Method for Soil Layers (Dr. Koezuka, Dr. Kohdzuma, Ms. Furihata, *NRICPN*)

- Based on the lecture, participants practiced the film removal method at the Heijo Palace site, where archaeological work is currently under operation.

- In order to take advantage of the waiting time for the resin to dry, a brief excursion was made to Wakakusa-yama Mountain to observe the location of the Heijo Palace Site from above. The Mountain is renowned for exposed andesite stone that were observed while walking along the path (it is prohibited to collect samples).

Workshop on the removal method for soil layers: washing away remaining soil layers.

<u>Dec. 8 (Wed.)</u>

Roll of Conservation Science (Dr. Kohdzuma, *NRICPN*)

- How "Cultural Properties" are defined by the Law for the Protection of Cultural Properties.
- The role of conservation science —methods and future issues—
  - Analytical survey: observation, structural survey, physical characteristics, using machines
  - How field surveys are conducted.
  - Problems on conservation and restoration.
  - Storage and exhibition.

Workshop: Removal Method for Fragile Artifacts

- Polyurethane foam method.
- Liquid nitrogen method.
- Plaster cast (gypsum) method.

Workshop: removal methods for fragile artifacts

Showing methods used in conservation science.

<u>Dec. 9 (Thu.)</u>

Conservation of Wall Paintings Ⅰ (Dr. Kohdzuma, *NRICPN*)

- Lecture on the discolouration of wall paintings.
- How to measure and judge the colours of artifacts and apply conservation methods.

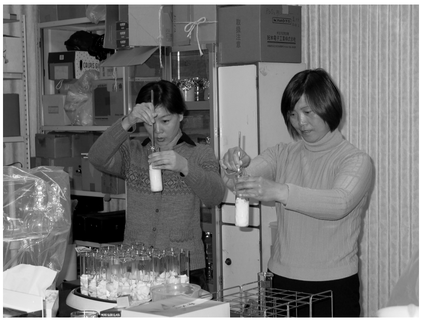
On-site Lecture: Conservation of Paper and Silk Paintings (Mr. Oka, *Oka-bokko-do*)

- Visit to the Oka-bokko-do Laboratory at the Kyoto National Museum, Kyoto. Restoration works for silk and paper paintings: silk screens, roll paintings, etc. are done in this laboratory.
- Basic restoration methods are the same for wall paintings and paper and silk paintings.
- New method for filling lost parts of paintings: the use of digital data

Visit to Oka-bokko-do Laboratory at the Kyoto National Museum: restoration work for paintings.

Experiment during the conservation science lecture.

Facility containing a sample and a collecting filter inside.



Workshop: sample extraction and preparing for analysis

Dec. 10 (Fri.)

Conservation of Wall Paintings Ⅱ (Ms. Furihata, *NRICPN*)

How to remove plaster and wall paintings from walls: method and use of chemicals.

Analysis of Materials (Dr. Naruse, Office of the Shosoin Treasure House)

- Visit conservation laboratory, Office of the Shosoin Treasure House.
- Short lecture about the Shosoin Treasure House and the role of the office.
- Analysis of a bronze mirror using the X-ray fluorescence measurement method: the source (region or country) can be detected using this method.
- Pigment analysis: use of the electronic microscope, and the X-ray fluorescence measurement method

Dec. 13 (Mon.)

Effects of Air Pollution on Cultural Properties Ⅰ

Workshop: Collecting Samples (Prof. Nishiyama, *Nara University*)

- Collecting sample columns for analyzing air pollution in the Nara City area
- Sample collecting facilities are already in place in the Nara City area, and once a month samples are collected and analyzed. Facilities are located at the Han'nya-ji Temple, Shosoin Treasure House, Kofuku-ji Temple, Kasuga Shrine, Toshodai-ji Temple, Yakushi-ji Temple, and at the Heijo Palace Site.

Dec. 14 (Tue.)

Effects of Air Pollution on Cultural Properties Ⅱ

Workshop: Analyzing Methods for Collected Samples (Prof. Nishiyama, Ms. Tohge, *Nara University*)

- Collecting samples for analyzing air pollution at the Nara University laboratories.
- Preparation of samples for processing: extraction and preparation for analysis.
- Placing the samples in the analysis machine.

Dec. 15 (Wed.)

Effects of Air Pollution on Cultural Properties Ⅲ
Evaluation of the Results (Prof. Nishiyama, Ms. Tohge, *Nara University*)

- How to calculate and establish the results: calculating the absolute value to compare with other data.
- Making a map for the concentration of certain gases from the results.
- How we can prepare the results for the protection of cultural heritage?
  - Law for restricting discharge of poisonous gases.
  - Changes in our lifestyle.
  - Surround cultural heritage buildings with trees: make a buffer zone, etc.
- Observe and compare samples of discoloured pigments.

Evaluation of the results: making a map of air pollution concentration.

Dec. 16 (Thu.)

On-site Lecture: Museum Management (Mr. Imao, *The Museum, Archaeological Institute of Kashihara*)

- Met Mr. Matsuda, Head of the Research Department of the Institute.
- Visited the Museum, Archaeological Institute of Kashihara.
- Lecture about the Museum: history and role, management of artifacts.
- Tour of the museum
  - Storeroom for records, wooden artifacts and ordinary artifacts.
  - Exhibition rooms.

At the storage room and exhibition room of the Museum, Archaeological Institute of Kashihara: Mr. Imao explaining the collection.

On-site Lecture: Excavation of Palace Site (Mr. Hashimoto, *Archaeological Institute of Kashihara*)

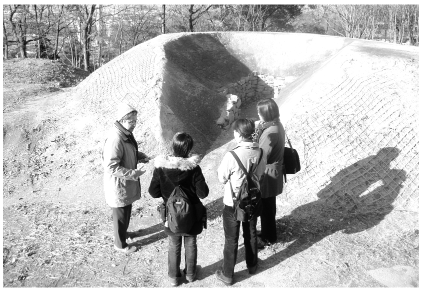
- Visited the Takamatsuzuka tumulus and museum. This tumulus has famous wall paintings in the stone chamber, the subject of a lecture during the course.
- Visited the excavation: the palace site of Asuka.
- See examples of reconstruction and utilization of archaeological sites: Ishibutai tumulus, Sakafune-ishi and Turtle-shaped stone object.

During the tour of the Archaeological Institute of Kashihara. Use of the electron microscope is explained.

Dec. 17 (Fri.)

Facility for Conservation Science Ⅱ: Archaeological Institute of Kashihara (Mr. Hashimoto, Ms. Kagitani, Archaeological Institute of Kashihara)

- Introduction and tour of the Institution, research methods, and the conservation of artifacts (done in the Institute).



An example of reconstructed tumulus at the Niizawa senzuka site was introduced.

At Ryukoku University: looking at the result of the computer imaging of the Bezeklik wall paintings.

Interview about the training course report.

- A 3D scanner machine measured a bronze mirror. This method makes it possible to compare each artifact accurately and objectively.
- How to manage decayed stone objects.
- Sugar-alcohol impregnation method for the preservation of wooden materials was explained.
  - Conservation work for metal artifacts: use X-ray before the treatment, remove rust, remove chloride and filling resin etc.

On-site Lecture: Exhibition on "Conservation Science and Ueyama-kofun Tumulus", Niizawa-senzuka Museum, Kashihara (Mr. Hashimoto, *Archaeological Institute of Kashihara*)

- This exhibition displyaed the conservation work done on the artifacts from this tumulus.
- Visited the area where hundreds of tumuli are restored and opened to the public. Some of them are reconstructed and show the details and position of the original stone chamber.

<u>Dec. 20 (Mon.)</u>

Computer Reconstruction of the Bezeklik Wall Painting (Prof. Xu, Dr. Sakamoto, Mr. Iwanari, Ryukoku University)

- Visited the Seta Campus of Ryukoku University. There is a laboratory for research on cultural properties that were brought back by the Otani expedition in the 19th century.
- Lecture on the reconstruction of wall paintings from Bezeklik Cave. Most of the murals were removed and stored in different museums. In this laboratory, digital data of these fragments and other examples of murals are used to reconstruct the original paintings on the computer.

<u>Dec.21 (Tue.)</u>

Training Course Report Writing (ACCU)
Interview about the Report

<u>Dec. 22(Wed.)</u>

Closing Ceremony (ACCU)

Outline of Domestic Activities and Report on the Protection and Restoration of Murals

DU Xiaoli
Hohhot Museum

I have been engaged in work at the Museum for almost 20 years. In my career, I have participated in field surveys at successive ruins at an ancient castle; general ruins and sites where cultural remains have been excavated; and exhibitions of historical folklore data on the Tumote (a tribe in Mongolia), and of the Manchus and Muslims in Hohhot, in the Inner Mongolia Autonomous Region. I am currently focusing on the preservation and restoration of murals, and supervising the protection and restoration of murals in Hohhot, Inner Mongolia. This work is the first step taken by the Museum in the direction of protecting the murals of Inner Mongolia, something that I regard as an important mission.

Inner Mongolia is abundant in mural ruins, including mural tombs (Donhan, Beiwei, Liao, Jin and Yuan), murals in temples (Ming and Qing) and murals in Aerzhai cave (Shih-shia and Yuan). These ruins provide vivid evidence of the ethnic cultures in different areas at different times in the Inner Mongolian region. The ruins reflect distinctive ethnic styles and regional characteristics that make them part of the precious Chinese cultural heritage.

In Inner Mongolia, removal of the murals in Dazhao Temple (大召寺) for preservation started in the 1980s. In the 1990s, due to urgent need, we started to partially peel the paintings on tomb walls found by archaeological excavation. The first scientific conservation of peeled murals is the special conservation and restoration project for murals in Dazhao Temple that started at the end of the 1990s. However, conditions for conservation and restoration differ among those peeled off and stored and those conserved at the site. For example, even for murals found in temples in the same area, the impact on murals differs by specific year, region, environment and climate. In particular, the ambient conditions of tombs are complicated. Therefore, the preservation of murals is a very complex task. The work I am engaged in at present is described below.

1. Protection and restoration of the murals of Dazhao Temple in Hohhot, Inner Mongolia

The murals in the sutra hall of Dazhao Temple in Hohhot, Inner Mongolia, were peeled off in 1985. At that time, 34.96 m^2 of murals were peeled off and conserved as an emergency measure to allow repairs to the wall behind them. Nobody at the time was skilled in peeling off murals, and thus numerous cutting lines from the peeling were made on the paintings. This has greatly degraded their artistic value. Reprocessing measures taken in the preservation and restoration of the murals in Dazhao Temple became the key to consideration of future measures.

In 1985, the surfaces of the peeled paintings of Dazhao Temple were coated with a reinforcing agent, and epoxy resin was applied to their back faces to create a strengthening layer. Aggregates for support and decorative frames were then provided for better handling in the exhibition. At the end of the 1990s, degradation of the murals worsened day by day, and the pigment layer started to disintegrate, detach and peel off. Cracks developed on the surface and deformed the paintings, and also the back side started to peel off; we had to tackle a difficult preservation job. In 1999, I started to survey the present state of murals in Dazhao Temple, and prepare a conservation and restoration plan. I am chiefly working on reprocessing from the view of conservation science to overcome damage to the murals in Dazhao Temple. This includes studies on the hardening of murals, separation of the epoxy resin layer from the back side and utilization of lighter materials. Up to now, I have managed to achieve the following results.

1) Completed material analysis of murals with the support of the National Research Institute for Cultural Properties, Nara.
2) Hardening of the painted face and separation of the epoxy resin layer from the back layer, cooperating with the Conservation Institution of Dunhuang Academy and the China National Institute of Cultural Property.
3) Ongoing tests on the creation of a support layer for the back layer of the murals using light materials.
4) My philosophy on the preservation of cultural properties is to conserve cultural properties under conditions that allow reprocessing by minimizing and reducing impacts. Accordingly, I pay particular attention to avoiding the detrimental effects of reinforcement and balancing materials so as to avoid mutual interference. I thus try to use traditional materials and techniques as much as possible and reduce the types of materials used.
5) My research achievements appeared in “China Cultural Relics News (中國文物報)” and “Research on Protection and Restoration of Cultural Properties (文物保護修復研究)”. I also made presentations at the “International Conference on Protection and Restoration of Cultural Properties” held by the China National Institute of Cultural Property in 2002; the “International Conference on Material Analysis of Ancient Cave Statues and Murals” held by the National Research Institute for Cultural Properties, Nara in February 2004; “Conservation of Ancient Sites on the Silk Road: Second International Conference on the Conservation of Grotto Sites” held by the Dunhuang Academy and The J. Paul Getty Conservation Institute, US, in July 2004; and “Commemoration of the 50th anniversary of the Archaeological Research Institute for Cultural Properties, Inner Mongolia: International Conference on Archaeological Culture of Changcheng (內蒙古文物考古研究所成立五十周年暨長城地帶考古文化國際學術會)” held by the Inner Mongolia Institute of Cultural Relics and Archaeology, in August 2004.

2. Completion of a conservation and restoration plan of tomb wall murals from the Liao Dynasty found in Toerji Mountain

A Liao dynasty tomb on Toerji Mountain was excavated by the Inner Mongolia Institute of Cultural Relics and Archaeology, as an urgent survey. This is an important ruin as it is counted as one of the top ten new archeological discoveries in 2004 in China. The excavated murals are genuine examples of the early styles of Liao tombs. The paintings had already peeled off from the wall in the tomb and fallen to the ground. We immediately prepared a conservation and restoration plan for these murals because they were found in a special condition.

3. Completion of ruins survey, and conservation and action plan reports on tombs of the Liao dynasty in Wuilbuge, Kunlun, Tongliao

These tombs are the family cemetery of a nobleman named Xiao of the Liao dynasty. Murals in the tombs were seriously damaged due to the natural environment and man-made destruction that has allowed air to enter the tombs and has also caused raindrop erosion. I completed the planning and reporting of an urgent conservation plan and its specific action plan.

4. Completion of a conservation plan for murals of the Ming dynasty temple in Meidaizhao, Batou

Meidaizhao is a castle built by the chief of a local Mongolian tribe during the Ming dynasty. A huge mural in the castle is a valuable and vivid record of the clothing, food, manners and cultural background of the local Mongolian tribes. However, the present degree of damage to the murals does not allow for optimism. Disintegration, peeling and separation are progressing, and the surface is weathered and has disintegrated into coarse particles or is swollen. The pigment layer is also being shed; the situation is serious. We reached the conclusion that scientific conservation methods need to be applied to conserve them on-site. A conservation plan is scheduled to be completed in October this year.

5. Preparation of a protection plan for murals in Aerzhai, Yikezhaomeng

This mural is the only cave painting found in Inner Mongolia so far. Our work centers on protection of the cave site and environment, and at the same time, conservation and restoration of the murals in the cave. I am now preparing a conservation plan, with actual conservation and restoration scheduled to start in 2005.

Bearing in mind that these are rare cultural and artistic assets created by different people from a different era to those we are most familiar with, and that there are differences in the degree of damage to each relic, it is necessary to take preservation measures that are appropriate to each damage condition by selecting appropriate conservation and restoration techniques, processing steps and measures.

The problems I face at present are as follows.

1) Since the back layers of murals are thin and fragile, I would like to learn about more effective types of solidification materials and appropriate techniques to prevent serious destruction of the painted face.

2) I would like to learn about light materials that can create a supporting layer for soil paintings and calcareous paintings, and appropriate types of adhesives.

I have been given a rare opportunity by the Asia/Pacific Cultural Centre for UNESCO. I am extremely fortunate to be here as one of the officers engaged in the protection of cultural properties in China. During my stay in Japan, I would like to learn about the philosophy behind conservation and restoration of the aforementioned murals and conservation techniques. In particular, I would be most happy if I could learn diverse methods of measuring and analyzing relics that need conservation using advanced scientific techniques, and gain a wider and deeper knowledge of efficient identification of material composition, nature, and performance. I also wish to further develop the protection of cultural properties in China and promote broader international exchanges and cooperation through information exchange with instructors and fellow researchers.

内蒙古壁画保护修复工作的报告

内蒙古自治区呼和浩特市博物馆
杜　晓黎

我从事文物博物馆工作近二十年，做过内蒙古呼和浩特地区历代古城遗址、遗迹、出土文物的田野调查，以及内蒙古呼和浩特地区土默特蒙古族、满族、回族历史民俗的陈列展示工作。近年来，主要进行壁画保护修复研究，主持内蒙古呼和浩特壁画保护修复中心的工作。这是内蒙古地区首次进入壁画保护领域，开展的一项重要工作。

内蒙古地区有着丰富的壁画遗存，以墓葬壁画（东汉、北魏、辽代、金代、元代)、寺庙壁画（明代、清代）和阿尔寨石窟壁画（西夏、元）为主，集中体现了内蒙古地区不同时期、不同地域的民族文化，具有强烈的民族风格和地区特征，是珍贵的中华民族文化遗产。内蒙古地区从八十年代初期开始对大召寺壁画的揭取保护，九十年代在考古发掘中抢救性揭取了部分墓葬壁画。对这些揭取壁画的科技保护，则始于九十年代末对大召寺壁画的保护修复项目。但无论是揭取的壁画还是原状环境保存的壁画，对保护修复的要求都各不相同。即使同时期寺庙壁画，也会因为年代、地区、环境气候的不同，对壁画产生的影响不同，而墓室壁画的情况则更是错综复杂，所以，壁画保护也是一件非常复杂的事情。

目前，我正在做的几项工作：

一、　内蒙古呼和浩特大召寺壁画的保护修复

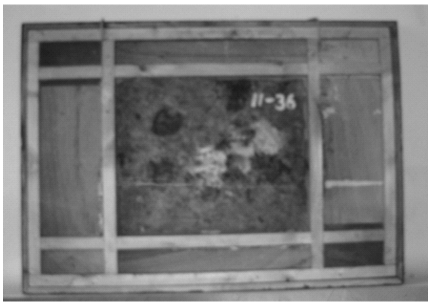
内蒙古呼和浩特大召寺壁画，是１９８５年从内蒙古呼和浩特大召寺经堂内揭取的。当时，因为大召经堂要进行墙体修缮，抢救性揭取了壁画，揭取保存面积３４·９６平方米。由于当时揭取技术所限，揭取切割线密集,破坏了画面的整体性和

1.内蒙古大召寺全景

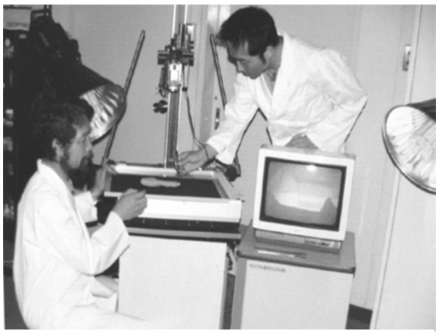
2.内蒙古大召寺经堂

3.大召壁画病害状况（起甲）

4.揭取后的大召壁画



5.壁画背部加固



6.奈良文化财做大召壁画分析

对壁画的艺术审美效果。对大召寺壁画的保护修复，其技术关键在于对揭取壁画的再处理。１９８５年，大召壁画揭取时在壁画表面涂刷了加固剂，壁画地仗层做了环氧树脂材料的支撑体，并加装了木龙骨和装饰框，便于陈列展示。到九十年代末，壁画病害日渐严重，颜料层出现粉化、脱落、起甲等现象，壁画裂隙、变形、地仗层脱落，壁画的保存受到挑战。１９９９年，我着手大召壁画的现状调查和保护修复方案的制定，主要针对大召壁画存在的病害问题，进行保护性再处理，包括对画面的加固处理和地仗层与环氧树脂材料支撑体的分离技术，以及轻型材料的应用研究。现在，已经取得了初步成果。

１、在奈良文化财研究所的帮助下，完成了壁画材质的分析。

① 在蓝色颜料中发现了一种玻璃结晶斑,经研究考证大召壁画使用的蓝色颜料是“苏麻离青”色料。

② 用红外线显微镜在红色颜料层下发现“工”字、青色颜料层下面发现“七”字。

２、 和敦煌研究院保护研究所、中国文物研究所合作进行壁画表面加固和地仗层与环氧树脂支撑体的分离。

３、 用轻型材料制作壁画地仗层支撑体的试验正在进行。

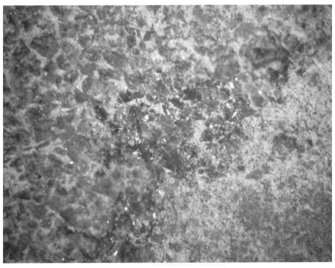
４、我所遵循的文物保护理念是对文物的“最小干预”和“可再处理”的空间，尽可能地采用传统材料和传统工艺，尽量减少应用材料的种类和减轻应用材料的强度，注意材料的兼容性。

５、我的研究成果，先后在《中国文物报》《文物保护修复研究》刊登，参加了 2002 年中国文物研究所主办的“文物保护修复国际学术会”、 2004 年 2 月奈良文化财研究所召开的“古代石窟塑像、壁画材质分析研究国际学术会”、2004 年 7 月敦煌研究院、美国盖蒂保护研究所召开的“第二届石窟遗址丝绸之路壁画保护国际学术会”、2004 年 8 月，内蒙古文物考古研究所召开的“内蒙古文物考古研究所成立五十周年

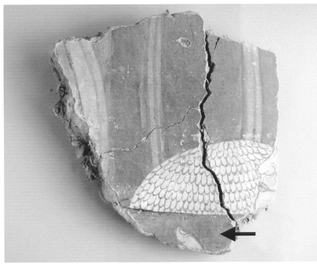
暨长城地带考古文化国际学术会”，并在会上都作了发言。

二、２００４年全国十大考古新发现之一吐尔基山辽墓壁画的保护修复方案的完成

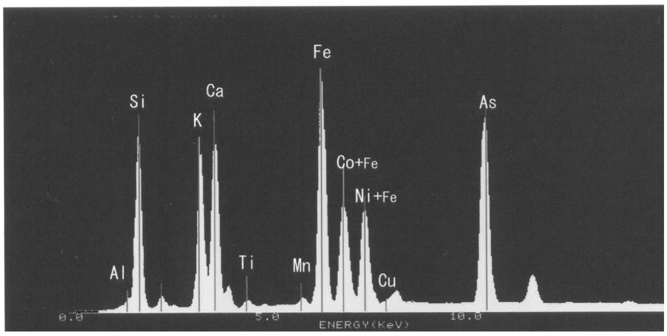
由内蒙古文物考古研究所抢救清理发掘的吐尔基山辽代墓葬，列入２００４年中国十大考古新发现，出土的壁画，是辽墓早期壁画的珍贵遗存。由于壁画在墓葬中已经从墓壁上自然脱落坠地，情况比较特殊，保护修复方案已经完成。



7.蓝色颜料分析



8.红外线照像观察



9.颜料元素分析

三、辽市库伦旗前勿力布格辽墓群的田野调查及保护方案及可行性报告的完成

通辽市库伦旗前勿力布格辽墓群，是辽代贵族萧氏的家族墓地，由于自然环境因素和人为破坏的因素存在，墓葬中的壁画因为空气的进入和雨水侵蚀，受损严重。拟定了抢救性保护方案及可行性报告。

四、包頭市美岱召明代寺廟壁畫保護計劃的完成

美岱召，是明代蒙古土默特部首領修建的城堡，大殿中繪製的巨幅壁畫，生動形象地再現了蒙古土默特部落的衣食風俗和文化背景，但壁畫的病害狀況不容樂觀，粉化、起甲、空鼓、顏料層脫落等病害比較嚴重。只有通過科學保護的手段，才能在原環境中更好地得以保存。今年１０月底，完成了保護計劃。

五、伊克昭盟阿爾寨石窟壁畫保護方案正在制定

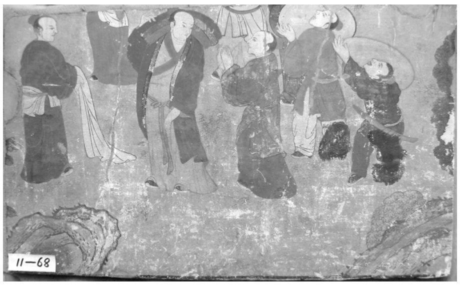
阿爾寨石窟壁畫，是目前內蒙古地區發現的唯一一處石窟壁畫。在完成石窟遺址與環境的保護的同時，對石窟內的壁畫進行保護修復，是非常關鍵的內容，保護方案正在制定當中，２００５年將開始具體的保護修復工作。

在壁畫保護修復中，我所面臨的是不同時期、不同民族創造的文化藝術珍品，它們的病害狀況也各不相同，在保護修復中的技術步驟和路線也需要區別對待、對症下藥。

10.壁画地仗层与环氧树脂加固层的

11.大召壁画的保护修复

12.修复前



13.修复后

我所遇到的問題：

一、　需要瞭解和掌握在壁畫地仗層薄脆、畫面碎裂比較嚴重的情況下可採用的加固畫面的材料種類和特殊工藝。

二、　需要瞭解和掌握可用來製作泥質壁畫、石灰質地壁畫支撐體的輕型材料和黏合劑的種類。

感謝亞洲文化遺產保護中心給予我這次可貴的學習機會，對於中國的文物保護工作者來說，是非常幸運的。我希望在日本的學習期間，能夠獲得相應的保護理念、保護技術方面的指導和啓發。特別是在運用先進的科學技術對保護物件所進行的各種測量和分析，更好地把握材料的結構、性質和性能等方面，有一個比較全面而深入的瞭解和認識，並且通過和老師及同行之間的學習交流，促進我們的文物保護事業的發展以及國際間更加廣泛的交流和合作。

14.库伦辽代墓葬群调查

15.辽代壁画揭取保存状况调查

16.辽代壁画病害状况调查

The Protection of Large Ruins and Cave Murals:
- An Overview of Xinjiang Uighur Autonomous Region -

WANG Qi
Cultural Heritage Protection Department,
Cultural Heritage Bureau of the Xinjiang Uighur Autonomous Region

Introduction

Xinjiang Uighur Autonomous Region is the largest inland province in China, with a total area of 660,000 km^2, or 1/6th of the entire country. For thousands of years, people have settled and lived in this vast land, leaving behind a rich cultural legacy. After the western region was unified during the Han and Tang Dynasties, the Xinjiang Uighur and Zhongyuan (Central Plains) areas became culturally closer.

The North, Central and East Routes of the Silk Road pass through Xinjiang Uighur from the very north to the very south. The Silk Road introduced the culture of Zhongyuan to Xinjiang Uighur, as well as strengthening political and economic relations between Xinjiang Uighur and the Zhongyuan peoples. Diverse cultural remains are dotted along the Silk Road, and the most important ruins of Xinjiang Uighur are also distributed along the Silk Road. These include the Ancient City of Jiaohe, the Ancient City of Gaochang, the ruins of Loulan, and the ruins of Niya.

In Xinjiang Uighur Province, 4,000 sites (cultural properties) are presently registered, including ancient ruins, ancient tombs, cave temples, and ancient structures. I am engaged in protecting and managing large ruins and cave temples. An overview of my mission is described below.

1. Preservation of large ruins

Countless castle ruins from the Han and Tang Dynasties can be found in Xinjiang Uighur Province. They are mostly located deep within the Turpan Basin and the Taklimakan Deserts. Most structures in the ruins were constructed applying natural soil. The ruins were preserved thanks to the unique climate in the Xinjiang Uighur area, which is dry with low rainfall. However, weathering and alkalization of the ruins are progressing significantly due to wind and sunlight exposure over the years, as well as a rise in the groundwater level.

In addition to the fact that the ruins stretch over a vast area, we are confronted with great difficulty due to a lack of funding and professional engineers to help preserve ruins. Conventionally, the ruins within the mountains are left undisturbed in their natural state, and scientific conservation is rarely applied. Only a few experimental attempts have been applied as scientific protection measures.

For example, PS agents were applied to the Ancient City of Jiaohe in the 1990s, in the hope of halting surface weathering of the architectural features. However, the surfaces separated or peeled off even when the agent was applied over several years, due to unsuccessful permeation of the agents and inappropriate selection of chemical agents.

Moreover, the agents are expensive and area of the ruins is too large. This protection measure is clearly not applicable to all ruins. The foundations of the ruins have alkalized, become weakened and brittle, and have disintegrated. However, preventing the peeling of walls at these ruins is the toughest challenge. During my current visit to Japan, I would like to learn from Japanese experts about advanced techniques for preventing alkalization.

2. Preservation of cave murals

Due to the fact that the Xinjiang Uighur area was the gateway for the introduction of Buddhism to China, countless Buddhist ruins such as cave temples remain. The structures of the Thousand Buddha caves in Xinjiang Uighur are diverse, and the subjects of the cave murals are also diverse, including the Jataka story, the fate story and Buddhist legends. Different kinds of painting methods and techniques are also used. In the 1980s, the protection of cave murals started to be given importance in Xinjiang Uighur. Before that, people had little understanding of the importance of heritage and conservation, and caves lay neglected. Local people even used caves as sheep pens. Some also made fires in the caves to warm themselves, resulting in the blackening of numerous cave murals. Non-scientific measures were then applied, and washing of the blackened paintings with water led to further destruction.

Major damage to cave murals in the Xinjiang Uighur region has been caused by alkalization, separation, peeling, blackening or staining by smoke, and discolouration. In the past, epoxy resin was used to protect cave murals. However, this method was attempted only for experimental purposes, and is not applied to a wide range of mural. If the paintings cannot be preserved at the site, another measure is to remove the paintings from the caves. The most challenging problem we face now is how to preserve the removed paintings. My immediate task concerning the preservation of murals is participation in "Conservation and Restoration of Kumtura Thousand Buddha Caves," a project given grant aid by UNESCO.

I have heard that Japan possesses advanced technology in the protection of murals, particularly regarding pigment analysis, survey of conservation environments, and the restoration and conservation of murals. During my stay in Japan, I would like to study the achievements in these fields and learn professional techniques in order to utilize them in my future work.

新疆工作情况介绍

大遗址保护及洞窟壁画保护

新疆文物局文物保护处

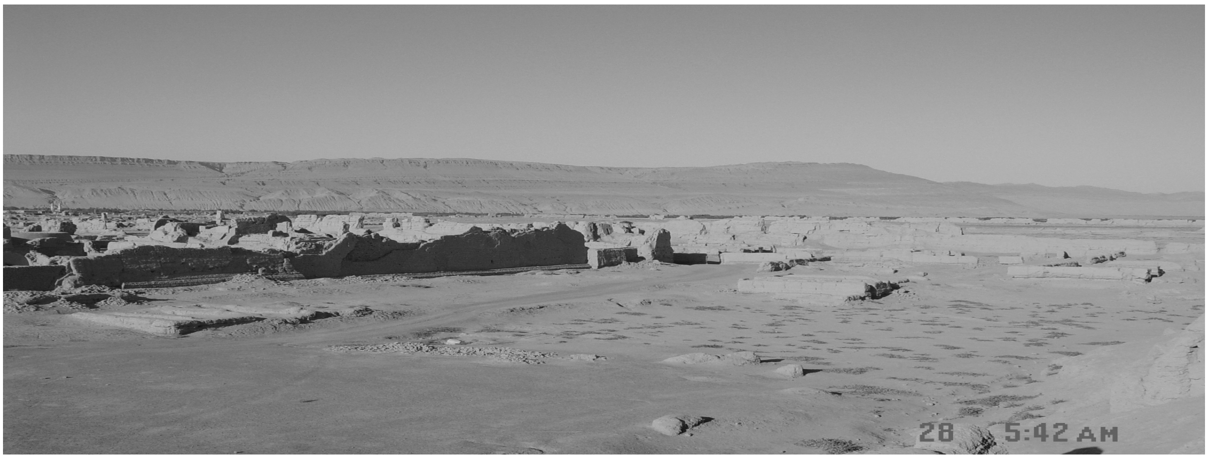
王　琦

新疆是中国最大的内陆省份，占中国国土面积的 1/6，总面积达 66 万平方公里。几千年来人类在这片广袤的土地上繁衍生息着，并留下了大量的文化遗产。自汉唐统治西域以来，新疆与中原的关系更加紧密。“丝绸 之路”从北到南贯穿了整个新疆境内，分为北线、中线、东线。“丝绸之路”不仅加强了新疆与内地在政治、经济上的联系，同时，中原文化也随之传入新疆。目前，在“丝绸之路”沿线保留有丰富的文化遗存，新疆许多重要的文物遗址大都沿“丝绸之路”分布，如：交河古城、高昌古城、楼兰遗址、尼雅遗址等等。新疆目前有 4000 余处文物古迹，包括古遗址、古墓葬、石窟寺、古建筑等。本人所从事的主要工作是对大遗址及石窟寺的保护管理工作，现就有关情况介绍如下：

1、 库木吐喇千佛洞周边环境

2、 莫尔佛寺遗址

3、 高昌古城城墙



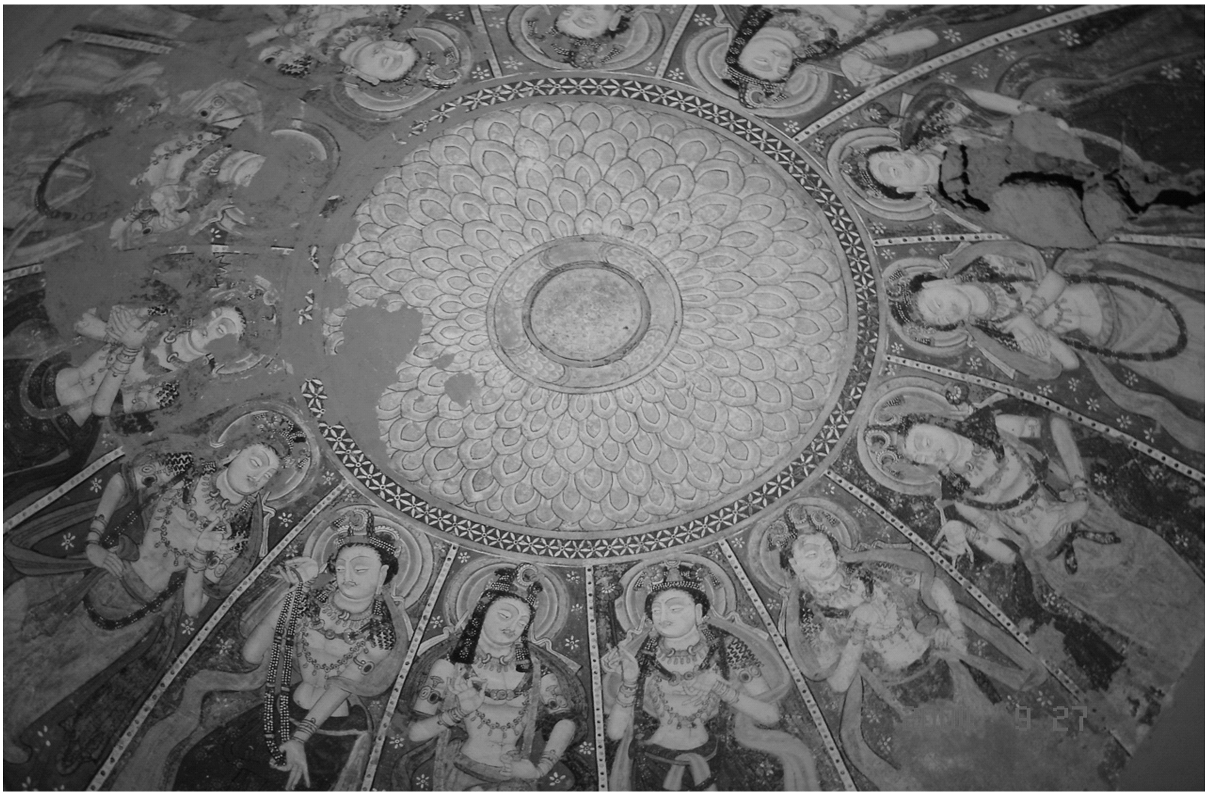
4、 高昌古城内城

一、 大遗址保护

新疆目前保存有许多汉唐时期的城址，主要分布在吐鲁番盆地及塔克拉玛干沙漠腹地，这些城址大都是生土建筑，由于新疆独特的气候特征，即干旱、少雨，使得这些生土遗址得以保存下来。但由于长年风吹、日晒以及地下水位的上升，遗址风化和盐碱化现象非常严重。由于缺少资金及专业技术人员，再加上遗址本身面积很大，因此给保护工作带来很大困难。目前，这些生土遗址的保护仍处在自然状态下，没有更多的科技手段。在以往的工作中仅仅采用了一些试验性的科技保护措施，如对交河古城的保护中，90 年代利用 PS 剂对遗址表面进行喷涂，以解决遗址表面风化的问题，但由于药品渗透不够及自身存在的问题，经过几年之后，喷过药品的地方开始起甲、脱落，也由于药品价格高，而遗址面积很大，所以此种保护方法没有普遍使用。至于因盐碱造成遗址基础松软而坍塌的问题更是难以解决。因此，此次来日学习，很想了解日本文物保护专业人员在解决盐碱方面的先进技术

5、 交河古城佛塔

6、 交河古城民居遗址



7、 库木吐喇千佛洞新 1 窟窟顶壁画

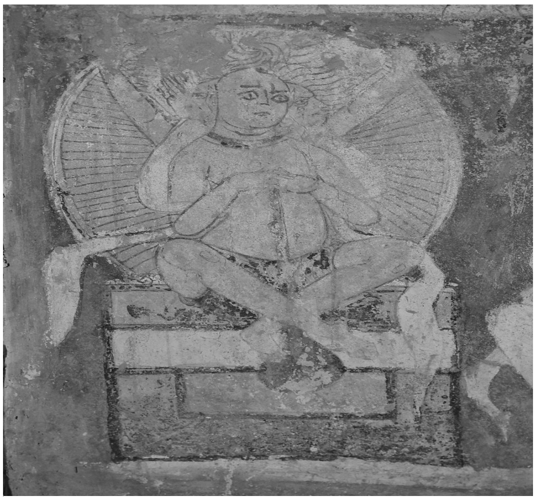
二、 洞窟壁画保护

8、 壁画局部

新疆是佛教传入中国的始端，因而在其境内保存有大量的佛教遗迹——石窟寺。新疆境内的千佛洞不仅洞窟造型多样且壁画内容丰富，包括本生故事、因缘故事、佛传故事等，绘画手法也呈现多样化。新疆从 80 年代开始重视洞窟的壁画保护工作，在此之前，由于人们的认识不够，洞窟处于无人监管状态。当地居民甚至拿洞窟当羊圈来用，在里面生火取暖，使很多洞窟的壁画遭到烟熏而变黑。后人在保护时又采用了不科学的手段，用水冲洗壁画，使壁遭到了更大的破坏。

目前，新疆境内石窟壁画的主要病害为酥碱、起甲、脱落、烟熏、褪色等。在以往的工作中曾采用了环氧树脂的方法对壁画进行保护，但也仅仅是在试用阶段，没有进行大规模运用。另外，当壁画原有环境已经不能保证壁画本身安全存在的情况下，对壁画要进行揭取，但揭取下来的壁画如何保护，也是当前迫切需要解决的问题。我

9、 克孜尔千佛洞壁画



10、克孜尔千佛洞壁画

目前的主要工作是参与联合国教科文无偿援助项目“库木吐拉保护工程”。

日本在壁画保护方面，尤其是在颜料分析、保存环境、壁画修复与保存方面具有先进的技术。因而，此次来日，很希望能在这方面多学习，掌握更多的壁画保护知识，回国后能在工作中运用。

Natural Science and Archaeology

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Introduction

The study of archaeological science builds on the foundations of such fields as archaeology, historical science, gardening history, and architectural history, collaborating with natural science disciplines in deepening the study of archaeology, history, and the like, and enabling the development and multidisciplinary expansion of new fields of study. Therefore, it is a discipline that cannot exist without the interaction and information exchange with a wide range of natural and human sciences fields, including physics, chemistry, biology, physical science, engineering, agriculture, and medicine.

1. The Beginning of Archaeological Science

When did the field of archaeological science begin? Since European scientists were conducting chemical analysis on coins as early as the 18th century, it can be argued that the field has a history of 200 years; however, the individual who first engaged in the study of full-fledged archaeological science was most likely Martin J. Aitken. In 1958, he set up the "Research Laboratory for Archaeology and the History of Art" at Oxford University, and published a periodical research journal titled "Archaeometry." We have decided to take the liberty of translating the term "Archaeometry" as *Kouko Kagaku*, which means Archaeological Science. Although it appears "Archaeometry" is usually translated more accurately as *Kouko Keisokugaku*, which means Archaeological Measurement, we chose the former because it seemed to present the first point of full-fledged archaeological scientific research. And since 1975, the international convention "Archaeometry" is convened every other year.

We shall now take a look at Asia. The Shanghai Museum in China publishes "Archeological Science for the Conservation of Writings and Objects." First issued in 1989, it is published twice yearly and carries articles on a large range of topics, from the analysis of archaeological artifacts to their conservation. In Japan, research in archaeological science began at the end of the 19th century, 100 years later than in Europe. Research in Japan mainly consisted of the analytical chemistry of archaeological materials. H.S. Munro, an American who assumed the professorship of geology and epigraphy at *Kaisei Gakko*, the predecessor of the University of Tokyo, conducted an analysis of a *dotaku*, a bell-shaped vessel of the *Yayoi* period, for the first time in Japan. He presented the results of his analysis at the academic convention in New York in February 1877. The individual who conducted the actual chemical analysis was a Japanese student. Another scientist, E. S. Morse, the zoologist who discovered the Omori Shell Mounds in Tokyo, gave a report in 1881 of his analysis of a large *dotaku*. It was only in 1900 that the Japanese researcher Ken'nosuke TSUJIMOTOI presented his analysis, "*Seido Seihin no Seibun Bunseki* (The Component Analysis of Bronze Products)."

One of the studies in archaeological science that created a furor in the Japanese archaeological community was radioactive carbon dating, a dating method established by the American chemist Willard Frank Libby (1908 – 1980). The method became the focus of attention in Japan through measurements taken in 1958 of the Natsushima Shell Mound, located offshore of Yokosuka City in Kanagawa Prefecture. The *Jomon* era shell mound had been excavated and estimated as being 6,000 years old using conventional archaeological research methods; however, the announcement, based on carbon dating of shells and charcoal, that the mound was in fact about 9,500 years old sent shock waves throughout the archaeological community. The application of scientific methods to archaeological research tends to result in this kind of unexpected measurement outcome, helping to deepen debate over the issue.

Another important field of research in the discipline of archaeological science is conservation and restoration science. In 1972, the discovery of the Takamatsuzuka Burial Mound in Nara Prefecture served as the catalyst for raising awareness of the importance of the application of scientific methods to the field of conservation, and helped to focus attention on the field of archaeological science.

2. Themes in Archaeological Science

Archaeological science refers to the study of archaeological materials using scientific methods. The information gained in this discipline can be used in historical or archaeological surveys and studies, or utilized for the preservation or restoration of archaeological materials. The use of scientific techniques for the study, conservation and restoration of cultural properties is a natural outcome of events; the following two purposes can be identified. They are: the study of archaeological sites and artifacts themselves; and using archaeological sites and artifacts as the medium through which to elucidate the science and technology of ancient times on a global level, that is, expanding the study into the history of science and technology. While themes in archaeological science cover a wide range, we will focus on five research topics and introduce their purposes and methodologies on the basis of results produced and cases handled to date.

(1) Scientific dating: In archaeology, relative dating techniques are used, where the age of a site or object is estimated based on the morphological comparison, whereas in studies involving the use of scientific methods, an absolute date can be given to objects. While a variety of scientific methods have been studied, physicochemical methods are effective in identifying

relatively recent dates, and other measurement methods are suited to making broad measurements of ancient times.

(2) Studies on the material properties, production technique, and estimated place of production: While the basic methods are mostly to do with material analysis of the artifacts, they are heavily reliant on non-destructive techniques given the difficulties inherent in creating specimens out of the objects. The most frequently used method is x-ray fluorescence analysis. However, archaeological artifacts are often found in a state of deterioration after having been buried for prolonged periods of time. Therefore, the surface of a given specimen does not necessarily reflect the material properties of the artifact, and there is a need for skills and technique to achieve reliable analysis results.

(3) Explorations into the living environment and eating habits of ancient peoples, and reconstructing the paleo-environment: This field of study is referred to as environmental archaeology. It is a wide-ranging discipline that relates to every aspect of human activity, such as estimating the diet of ancient peoples through the analysis of animal and plant remains, studying the ecology of organisms, analyzing pollen and toilet soil to identify parasite eggs and explore the ancient diet, conducting plant opal analysis and volcanic ash analysis to explore the state of agriculture and conduct comparative studies of stratigraphical dates, surveying the traces of earthquakes to determine changes in archaeological sites and their relationship with chronological periods, and attempting to reconstruct the paleo-environment on the basis of diatom analysis and phosphorus analysis. Meanwhile, scientific analysis of human bones, DNA analysis, and other studies of state-of-the-art technology relating to recent applications of biochemistry are also being vigorously pursued.

(4) Archaeometrical research: Morphological surveys of architectural structures and burial mounds utilizing computer graphics; research and development of underground radar and other surveying methods for ancient ruins; etc. When a person goes to a hospital, they are first given x-rays and blood tests to find a diagnosis, and treatment starts from there. In much the same way, the excavation of an archaeological site would proceed more accurately and efficiently if the site were surveyed and knowledge of the site obtained before excavation is begun.

(5) In order to conduct archaeometrical research projects with more accuracy, the safe preservation of the information contained within the archaeological artifact is of the first

order of importance. In addition, it is necessary to preserve and utilize the priceless archaeological site and artifacts. Research is needed into the development of technologies and materials that lengthen the lifespan of these objects, as well as that allow their permanent preservation. In that sense, this discipline is one of the most important fields in archaeological science.

3. Age Determination

1) Radioactive carbon dating

The carbon dioxide within the atmosphere is fixed into plants through photosynthesis. Because animals consume those plants, the carbon in the air is consumed as long as organisms are alive. Carbon has three radioactive isotopes, each with a different mass number. The isotope with a mass number of 14 (C14) has a uniform rate of formation when exposed to cosmic rays of a certain intensity, but once an organism dies, the concentration of C14 decreases with time due to radioactive decay. The time required for the amount to be decreased by half, that is, the half-life, is approximately 5,730 years. It is possible to estimate the date of creation of an archaeological specimen, for instance, a wooden artifact, by determining the degree of decrease of the C14 contained within that specimen.

2) Tree ring dating

This method, devised by the astronomer A.E. Douglas, takes advantage of the fact that the width of tree rings fluctuate in response to changes in climate. Douglass investigated the fluctuations in climate using tree rings, in order to study the sunspot cycle. In his methodology, the first step was to take advantage of the fact that the width of tree rings changed in response to meteorological conditions, and create a fluctuation pattern of tree ring widths that went as far back in time as possible from the presently living tree. The next step was to use that fluctuation pattern, or master chronology, for cross-referencing of the tree rings of a specimen of unknown age. In this way, the year of felling of that specimen could be determined. In Japanese archaeology, it is now possible to determine the age of a given archaeological site using *hinoki* cypress, *sugi* cedar, and *koyamaki* pine, all of which are unearthed in abundance. At present, master chronologies have been completed up to 912 B.C. for *hinoki* cypress, 1313 B.C. for *sugi* cedar, and 22 A.D. for *koyamaki* pine. However, while it is possible to obtain an accurate felling year with specimens that have a portion of the bark, or the outermost tree ring, remaining, this is not true of specimens which have had the sapwood portion trimmed off. For the latter, only the upper limit of the estimated year of felling can be obtained.

3）Heat luminescence

When radiation strikes the inorganic substances fluorspar (CaF2, isometric system) and quartz (SiO2, the main component of igneous rock), these substances drive out electrons from the atoms that compose them. These electrons move around inside the substance, are captured within holes in the crystal, and become imbedded. These remain fixed for many years, and as radiation continues to strike the substance, the number of electrons captured in this manner continues to rise. Moreover, the captured electrons are proportionate to the total radiation dose. When such crystals are exposed to excitation energy, the atoms begin to vibrate and the captured electrons are released. These electrons re-bind with the hole center via the conductor, and give off "luminescence." For instance, when a piece of earthenware is heated, the intensity of heat luminescence, which corresponds with the total radiation dose that specimen received after it was fired, can be measured. By exposing that same piece of earthenware to a known dose of radiation, and measuring the amount of heat luminescence obtained, it is possible to measure the unique luminous efficiency of that specimen. At the same time, when the amount of natural radiation can be determined, it then becomes possible to calculate how many years the specimen had been exposed to radiation, that is, the year in which that piece of earthenware had been created.

４) Other

(1) Paleomagnetism and archaeomagnetism

The magnetic ores within soils that are exposed to heat, that is, the magnetic iron ore and red iron ore, are magnetized parallel to the earth's magnetic field at the location where the highly heated soil is cooled. This magnetic orientation is called thermal remnant magnetization, and matches the orientation of the earth's magnetic field at the time the soil was exposed to heat. Because the earth's magnetic field changes gradually with time, the age of residual magnetization can be estimated by cross-referencing with the direction of the earth's magnetic field under the effect of the magnetic north. In archaeology, it is possible to determine the age at which a firing kiln was last used, since the earthen walls of kilns used for the manufacture of earthenware articles is unchanged at that location.

(2) Electron spin resonance (ESR)

A method whereby the age of such articles as fossilized bone, paper, lacquer, and leather is determined through the measurement of the state of electrons. This method takes advantage of the fact that when objects are exposed to radiation, or when they undergo such responses as oxidization and degradation, the electron configuration of that substance becomes abnormal, giving the substance magnetic properties. This method can also be used to investigate the state of deterioration of such organic substances as silk and synthetic resins.

(3) Potassium-argon dating

Natural potassium contains radioactive potassium, which undergoes radioactive decay to become argon. By measuring the amounts of potassium and argon contained in rock and minerals, it is possible to determine the age in which they were created. In archaeology, this method is used to determine the age of formation of volcanic ash and mineral deposits associated with archaeological sites. In this way, useful information can be extracted and utilized for research purposes.

(4) Fission-track dating

A method of chronological dating that takes advantage of the properties of uranium. The uranium within minerals with a high uranium content undergoes nuclear fission, becoming a heavy fragmented nucleus with about half the atomic weight, that flies out at a high speed and damages the crystal structure along its track. The damage disappears when heated, and increases anew thereafter. By measuring the number of such tracks, and the uranium content, it is possible to obtain the time lapsed since an object was heated. From this, it is possible to determine the date of creation of earthenware and glass articles as well as the period in which volcanic ash was accumulated.

(5) Obsidian hydration dating

A method of chronological dating that is based on the measurement of the thickness of the hydration layer of obsidian. Obsidian that has been recently formed presents a black, glassy sheen. However, with the passage of long periods of time, obsidian formed in ancient times has undergone the hydration of its crystal lattice by permeating water molecules. With the passage of time, the hydration layer infiltrates deeper within the rock. By measuring the thickness of the hydration layer of obsidian unearthed from archaeological sites whose dates are known, it is possible to estimate the age of creation of obsidian articles by measuring the thickness of the specimen’s hydration layer.

4. Materials, techniques, and place of production

1) Materials

In addition to such archaeological techniques as comparing the types and forms of archaeological artifacts, scientific methods such as the comparison of materials can be used in the research of the trading zones of archaeological artifacts. For instance, it is possible to identify the place of production of a given earthenware article, or the place of production of the clay used in its manufacture, by comparing the results of chemical analysis of that article against the results obtained from earthenware unearthed from a kiln site or articles known to have been created in a specific location.

2) Techniques

Archaeological artifacts come in every conceivable shape, size, and composition. The general procedure is to examine the production technique of a given specimen on the basis of structural analysis using optical equipment. In the scientific analysis of an earthenware article, methods such as petrological observation, x-ray transmission photography, and physical investigation through thermal analysis can be used. X-ray transmission is also effective in the research of casting techniques for bronze articles. There is also a method that takes advantage of the composition of bronze articles. Bronze is an alloy of copper and tin, with the admixture of lead. Lead and copper segregate instead of forming an alloy. In addition, due to their heavy specific gravity, these elements tend to sink to the bottom of the crucible. Therefore, when the molten mix is poured into a cast, the portion of the mix with higher concentrations of lead tends to be poured last, resulting in an uneven distribution of lead concentration within the same article. This can be used as the basis for determining the direction of the cast, which can lead to the elucidation of casting technique. The manufacturing technique for glass beads and lacquer products can be explored by the analysis of materials and structure.

3) Place of production

In addition to such archaeological techniques as comparing the types and forms of archaeological artifacts, scientific methods such as the comparison of materials can be used in the research of the trading zones of archaeological artifacts. In studies which attempt to identify the place of production of metal articles, earthenware crafts, roof tiles, and stone tools, the non-destructive and speedy technique of fluorescent x-ray analysis is often used. In order to investigate the exchange zone of earthenware articles, it is necessary to identify where the article was made, and where it was used. Another method uses the isotopic ratio of lead, which is determined by the date of creation of the lead deposit, and which is known to present a unique value for each geographical area. This method makes it possible to estimate the place of production of articles that contain lead. That is, by calculating the unique isotopic ratios of each mine, it is possible to estimate the place of production of bronze articles, lead glass, and glazes that contain lead.

5. Reconstruction of the paleo-environment

1) Reconstruction of the living environment and eating habits

A variety of analytical methods can be used to explore the living environment and eating habits of ancient peoples. These methods include the analysis and identification of plant and animal remains, DNA analysis, and fatty acid analysis. Deoxyribonucleic acid (DNA), which is the substance of the gene and controls the shape and properties of living things, can be extracted from dead creatures for analysis. DNA analysis of human bone can provide clues into the origins of humanity and its propagation, while DNA analysis of organisms can aid in the identification of species, seeds, or individuals. In this way, DNA analysis can be used effectively in the study of biological evolution and in estimating ancient growth and development conditions.

2) Study of environmental and climatic changes

The paleo-environment can be reconstructed through such means as the observation of volcanic ash, traces of earthquakes, diatom analysis, phosphorus analysis, pollen analysis, and plant opal analysis. Pollen reflects the realities of flora, and flora is intimately associated with climatic conditions, soil conditions, and human lifestyles. By extracting and analyzing the fossilized pollen buried in the layers of sediment covering an archaeological site, it is possible to calculate the relative quantity of that particular plant in relation to the total quantity of all plants during that period. The changes over time of the relative quantities of different plant species can illuminate the historical changes in the ancient flora, and provide clues into the living conditions and living environment of ancient peoples through estimating the changes in the ancient climate and environment.

3) Pollen analysis

Pollen reflects the realities of flora. Flora is intimately associated with climatic conditions, soil conditions, and human lifestyles. By extracting and analyzing the fossilized pollen buried in the layers of sediment covering an archaeological site, it is possible to calculate the relative quantity of that particular plant in relation to the total quantity of all plants during that period. The changes over time of the relative quantities of different plant species can illuminate the historical changes in the ancient flora, and provide clues into the living conditions and living environment of ancient peoples through estimating the changes in the ancient climate and environment. In addition, reconstruction of the ancient flora can help to determine whether a given geographical site was marshland or arid land, and further provide more specific information on the situation of the land and soil.

6. Prospecting and metrology

These methods refer to techniques whereby buried ruins and artifacts are explored without digging them up. By sending radio waves into the ground, and by collecting such information as the intensity by which the reflection comes back to the surface, the refraction and attenuation of the waves, the differences in the electric resistance of different types of soil, and subtle magnetic anomalies, it is possible to determine where the soil is different, or distinguish foreign objects other than soil. This information can be combined with archaeological information in a comprehensive examination to survey archaeological sites and artifacts, and to shed light on their nature. In recent years, the term "prospecting of cultural properties" is sometimes used to refer to scientific prospecting methods not only for archaeological sites but also for various cultural properties including buildings made of stone or wood.

Because it deals with archaeological sites and artifacts, the most important factor in the prospecting of an archaeological site is to reference existing survey results of that site and surrounding areas when attempting to understand the prospecting results, and to fully consult with the persons in charge of archaeological investigation. When anomalies are found as a result of the prospecting, it should be possible to gain a deeper understanding of the cause of said anomalies by referencing conventional prospecting results of that site as well as the situation of sites in surrounding areas.

1) Radar surveys; electrical prospecting; magnetic prospecting

The techniques whereby buried ruins and artifacts are explored without digging them up are referred to as archaeological prospecting. By sending radio waves into the ground, and by collecting such information as the intensity by which the reflection comes back to the surface (radar), the refraction and attenuation of the waves, the differences in the electric resistance of different types of soil (electrical prospecting), and subtle magnetic anomalies (magnetic prospecting), it is possible to determine where the soil is different, or distinguish foreign objects other than soil. This information can be combined with archaeological information in a comprehensive examination to survey archaeological sites and artifacts, and to shed light on their nature.

2) General metrological science

The recent advances in computer technology have been occurring in every conceivable field, and the realm of cultural properties is no exception. These advances are being actively utilized in solving metrological challenges posed by cultural properties, correction and reconstructing of images, and in the analytic and metrological instruments themselves. The term refers to all fields of metrological science that are applicable to the study of cultural properties. Computer graphics are a typical example.

7. Conservation science

This term refers to the multidisciplinary field of study where scientific techniques are applied for the purposes of investigation or conservation and restoration of cultural properties. Methods include material analysis, structural analysis, environmental analysis, and development of restoration techniques. In material analysis, it is preferable to use non-destructive methods. For the investigation of inner structures, which cannot be seen by the naked eye, such means as x-rays, infrared rays, and ultraviolet rays can be applied. CT scanners are an effective means of x-ray transmission. In studies of the preservation environment, research into such matters as air, temperature, humidity, and lighting is conducted with the purpose of environmental conservation, while efforts are made to construct an appropriate environment. In the conservation and restoration of artifacts, traditional techniques are respected while research and development, as well as improvements and modifications, are made to restoration techniques and materials that maximize the latest scientific technologies.

1) Archaeological sites (Residential ruins, kiln ruins, burial mounds, stone buildings, maintenance of archaeological site)

(1) <u>The purposes of archaeological site maintenance</u>

① To give the general public a proper awareness of the nature of the archaeological site. Exposing the remnants of ancient structures for display, or reconstructing facilities such as buildings, can make a site easier to understand and appreciate properly.

② To lengthen the life of the archaeological site. The process of maintenance and continued management are what achieve the preservation of the site. The process also helps to deepen understanding of the site. Also aids in the advancement of conservation and restoration techniques.

③ To make possible the construction of an environment that allows the archaeological site to be preserved as is, without losing the information inherent in the site. To preserve and manage a site without making light of valuable information that cannot be measured with current science and technology. Archaeological sites have the potential for extracting more information with advances in science.

(2) The significance of site maintenance

① Handing down the legacy of the site as a cultural heritage: Academic evaluation of a cultural property; historical positioning of a cultural property; creating a hub for cultural exchange;

② Urban planning: Development of the area around the archaeological site;

③ Community-building: Harmonization with the local community; community service function; planning events with participation by the general public; utilization of volunteers; archaeological site as a place of relaxation;

(3) Ancient buildings and burial mounds

An example of the comprehensive conservation of a burial mound is the Takamatsuzuka Burial Mound in Nara Prefecture. In order to safely protect the facility, the environmental conditions within stone burial chamber are maintained in a state close to what they were prior to the excavation. That is, the conservation system is designed to maintain the temperature and humidity (at least 96%) at the time of excavation. Other important challenges include dealing with mechanical problems stemming from the structural makeup of the stone chamber, and measures to address bacterial and fungal growth. Generally speaking, each burial mound has its own environmental and geographical conditions, and must be addressed individually.

(4) Stone monumental architecture

Examples of stone monumental architecture include stone carvings of Buddha (*magaibutsu* (stone cliff Buddha)), stone towers, stone towers dedicated to Buddha and Prabhutaratna, stone monuments, stone architecture, decorative rocks used in gardens, cornerstones in residential ruins, stone burial chambers in burial mounds, and caves. Because there are a large number of volcanoes in Japan, it is said to be rich in tuff. The poor consolidation of tuff makes it extremely vulnerable to degradation, not only on the surface but structurally as well. Therefore, stone cliff Buddhas and stone caves carved into bedrock require more than cosmetic conservation and restoration on the surface. They need preservation work to be done from the standpoint of structural mechanics. In addition, portions where there are joints running through the bedrock are prone to start cracking and/or degrading. On the other hand, the components of tombstones and stone monuments are usually made of granite, andesite, basalt, greenschist, and other materials that are partly uniform and dense. Even so, one finds that many of them still degrade and disintegrate.

There are usually multiple factors leading to degradation, and these factors are intertwined organically. In particular, a major factor is the damage due to the weathering of salts, and due to repeated freezing and thawing. When water with salt content evaporates from the surface of rock, the salts precipitate onto the surface. Or water may infiltrate the rock and cause salts to precipitate when it dries. When this action is repeated, the crystals damage the surface layers of the rock, and excessive salts form a hard, crust-like coating on the rock surface. While at first glance this may appear to increase the strength of the rock, it is actually brittle and crumbles easily. It is typical for the inside of the hard coating to have turned into clay, causing many of the structures to crumble with increasing speed. Stone cliff Buddhas are vulnerable to damage caused by tree roots, and continuous vibration from automobiles, as well as the effects of earthquakes, are serious problems. Another major issue requiring appropriate preservation measures is biological degradation caused by lichen and microorganisms. While epoxy and acrylic synthetic resins are used to strengthen rock, silane synthetic resins have also come into frequent use in recent years. It would be ideal if, in addition to strengthening with synthetic resins, a monument can also be protected by means of a covering roof or other such structure.

<u>(5) Transcription of soil layers; relocation of remains of archaeological structures; reconstruction models</u>

There is a technique whereby the soil layer or cross section of an archaeological site is shaved off thinly, transcribed to a cloth or panel etc., and taken indoors. In this soil layer transcription technique, the first step is to shave off the surface of the object for transcription so that it is as smooth as possible. Even when an archaeological artifact is included in this potion, it is allowed to remain as is as a general rule, and is transcribed together with the soil layer cross section. Adhesive is applied to the surface of the soil layer cross section, and a cloth is pasted on to strengthen the film. Epoxy and urethane adhesives can be used. After hardening, the soil layer cross section is shaved off thinly. Generally speaking, the stratigraphy of a soil layer cross section is more distinct when wet. Therefore, isocyanate synthetic resins may be applied to the surface of the soil layer cross section that was shaved off, thereby artificially inducing the wet coloring.

When dealing with archaeological remains that cannot be preserved at its original location, or when handling artifacts that have become too brittle to pick up with the bare hand, or when transporting cut-off sections of large remains into an indoor environment, techniques are sometimes used whereby the objects are packaged in rigid urethane resin for relocation. At other times, they may be packaged in concrete or plaster for transport. Reconstruction models are usually displayed in museums and art galleries, and for this reason their texture and coloring have been considered important technical challenges. However, models that convey a sense of mass and that have a texture that is similar to the original lend themselves to utilization as displays that people can touch and feel. In recent years, there is an increasing trend toward outdoor display, which has necessitated the development of materials and manufacturing techniques that make the models resistant to ultraviolet rays and rain.

2) Artifacts

When preserving and restoring specimens that are cultural artifacts, records of the chemicals and restoration techniques that were used should be kept together with the priceless cultural artifact. Meanwhile, consideration should be given to making the repairs in a manner that allows the repair to be done over when a better preservation material or technique has been newly developed.

<u>(1) Organic artifacts</u>

Organic artifacts include wooden articles, lacquered goods, bamboo products, and goods made from fibers (ropes and knit articles made of vegetable fiber, textiles such as silk and linen, etc.). Usually, archaeological artifacts are unearthed from sites that are moist. They are supersaturated with water, and when inadvertently allowed to dry, may crack, shrink severely, or become so deformed it is impossible to tell what it looked like originally.

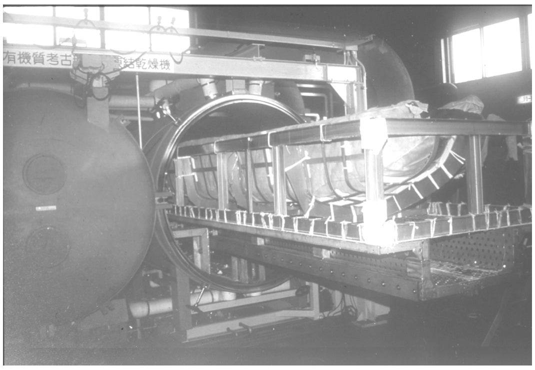

Fig. 1: Facility for PEG method

Wooden articles are the most numerously unearthed of organic artifacts. A variety of chemical treatment methods have been developed for their preservation. The “PEG impregnation method” consists of replacing the supersaturating water with polyethylene glycol (PEG) to stabilize the form. PEG is an ethylene oxide polymer that is categorized into liquid or solid form according to the difference in degree of polymerization. It is a stable chemical substance that is water soluble. Another effective method is “vacuum freeze drying," wherein the water content is prefrozen and allowed to sublime under high vacuum. By replacing the water content beforehand with organic solvents, and shortening the drying time, it is possible to avoid cracking or shrinking of the wood material. Compared to PEG, the "higher alcohol method" is an efficient method that requires a shorter processing time. Higher alcohol refers to those types of alcohol with a high carbon content, such as cetyl alcohol [$CH_3(CH_2)_{14}CH_2OH$] and stearyl alcohol [$CH_3(CH_2)_{16}CH_2OH$]. This method is suited for the preservation of textiles and other goods made from vegetable fibers, seeds and other plant remains, and artifacts that are composed of a combination of materials, such as metal and wood. Silicone resins, which are flexible, can do reasonable justice to flexible artifacts. Silicone is a general term that refers to organic silicon compound polymers, and depending on the size of polymerization (molecular weight between 300,000 and 600,000), presents in different states, such as lipid, grease, or rubber. For the preservation of organic artifacts, resins with relatively large polymerization are used. Silicone resins are highly water repellant and have excellent resistance to moisture and climatic conditions.

<u>(2) Inorganic artifacts</u>

Inorganic artifacts include metal products, stone tools, and earthenware articles. In particular, metal products are unstable and corrode notably quickly. Out of articles made of such metals as gold, silver, lead, tin, iron, and their alloys, iron articles are the least stable and require research into methods for their conservation and restoration. Copper and bronze products also involve complex degradation factors, and methods for their preservation are being researched. On the other hand, stone and earthenware articles are relatively stable, and do not present very serious problems in terms of preservation technique. When the surface portions have degraded, synthetic resins can be used to coat them.

The process of preserving metal products starts with cleaning to remove surface rust and adherents. X-ray transmission photography may be used as necessary to verify the original form that was obscured by surface rust. In order to rustproof the material, the rust-causing chloride ions are removed, and the material strengthened by allowing synthetic resins to infiltrate well. Distilled water or alkaline solutions are used for chloride ion removal. Some methods involve the use of an alcoholic solution of lithium hydroxide to desalt an article, or steeping the article in distilled water and boiling in a decompression chamber. Iron articles that were unearthed from sites at the ocean bottom are allowed to steep for long periods of time in sodium hydroxide solutions to extract and remove chloride ions. After desalting, the article is strengthened by impregnating with acrylic synthetic resins under vacuum.

3) Challenges in conservation science

(1) Ethics and philosophy of conservation and restoration

As international exchanges have become deeper and more frequent, national differences in preservation philosophy have come into bold relief. Since the structures and materials of cultural artifacts differ with each country, it is only natural that the philosophy and techniques for their preservation should likewise be different. Even within the same country, each restoration technician has his or her own philosophy, and these must be respected. That said, however, mistaken approaches must be rectified. For that purpose, dialogue between interested parties is essential, and forums such as academic conferences should be taken advantage of, since they offer a constant means for debate.

In several progressive nations, notably in Europe, ethics policies and practical criteria have been formulated for conservation and restoration, with projects proceeding in observation of these policies and criteria. What was once a world of oral tradition, apprenticeships, and secret techniques is now becoming one where there is an increasing call for well-organized educational curriculums and effective teaching materials that allow anyone to train and study equally. The policies and criteria enacted by the four groups ICOM-CC, the European Confederation of Conservator-Restorers' Organisations (ECCO), the American Institute of Conservation (AIC), and IIC-Canada served as the foundation. They consist of the following six items: Consideration for preservation and utilization; respect for cultural properties; self-improvement; respect for fellow professionals; contribution to the prosperity of the entire industry; and integrity.

(2) Problems with conservation science techniques

Conventionally, the challenge was to preserve the morphology of already degraded artifacts and prevent them from further deterioration. However, there are new challenges in conservation science now, relating to endeavors to reproduce the original properties and functions of artifacts. For instance, efforts are being made toward the development of methods that impart strength to wooden building materials after chemical treatment, so that they may be used for building again; or attempts are made to reproduce the original flexible state of a cloth article that has become fragile and brittle. In that sense, there is no point of arrival for conservation science. No point is good enough; the vital thing is to constantly pursue better and more effective methods.

(3) International exchange

The World Heritage Convention was adopted at the 1972 General Conference of UNESCO. Japan assented to this Convention in 1992. This Convention recognizes that parts of the cultural and natural heritage are of outstanding international value and are therefore a part of the world heritage of mankind as a whole, and aims to have countries work together for the conservation of these parts of the heritage when they are in danger of damage or destruction. Criteria for a heritage to be registered as a World Heritage were established from expert perspectives. However, there are national differences to the approach to the conservation of cultural heritages, as well as differences in standards and regulations governing conservation and restoration.

(4) Facilities and organizations

There are a number of national bodies with the function of conducting scientific research on the conservation of cultural properties: they are the National Research Institutes for Cultural Properties (Tokyo and Nara) controlled by the Cultural Agency; the Tokyo National Museum; the National Museum of Ethnology; the National Museum of Japanese History; and the National Museum of Western Art, which all have organizations for the research of conservation science. However, the number of experts who belong to those bodies come to a grand total of slightly over 30.

By comparison, in Europe, there are a large number of renowned museums and art galleries just in the city of London alone, almost all of which have laboratories for conservation science. The British Museum and National Gallery each have 80 or so experts on conservation and restoration. Their ranks include natural scientists, conservation and repair technicians, carpenters, turners, and painters. For that reason, they are capable not only of analysis and conservation of artifacts but can even build display cases and artifact stands with their own hands.

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Glossary of Terms

Fluorescent x-ray analysis

When x-rays are applied to a cultural property of unknown composition, the elements composing the specimen are excited, and generate secondary x-rays that are unique to the element. Those secondary x-rays are also called fluorescent x-rays. Their wavelength and intensity can be used to identify the elements contained as well as to measure their content. It is a non-destructive method of analysis consisting solely of x-ray irradiation, and is suited to the investigation of valuable cultural properties.

Measurement of carbon and nitrogen isotopes

This is one of the metrological methods utilized in archaeology. A mass spectrometer is used to measure the carbon and nitrogen isotopes (13C/12C, 15N/14N) contained in human bone, and on the other hand, to measure the carbon and nitrogen isotopes in the food resources that ancient peoples must have eaten. By cross referencing both groups of data, it is possible to identify whether a given group of humans subsisted mainly on marine products, meat, or fish, and estimate the eating ecology of ancient peoples.

Radioactivity analysis

In this method, an archaeological specimen is activated by being made to absorb neutrons, and its radioactivity (usually gamma rays) is measured to identify and quantify the elements contained in the specimen. This method is particularly effective for the quantification of component elements that are contained in trace amounts, and for the identification of the place of production (à method for identification of place of production) of ceramics on the basis of analyzing the trace components contained in the clay matrix.

Photogrammetry

This method involves taking measurements of, or deciphering, the shape and size of objects recorded in photographs. Depending on the position from which the photograph is taken, photogrammetry can be categorized into three groups: Aerial, terrestrial, and underwater. This method was first applied to the field of cultural properties in the latter half of the 1950s. Some early examples include the creation of a topographical map of the Heijo Palace Site, and the drawing of a three-dimensional drawing of the Great Buddha of Kamakura.

Isotopic ratio of lead

The isotopic ratio of lead is determined by the date of creation of the lead deposit, and is known to present a unique value for each geographical area. That is, each mine presents a unique isotopic ratio. By calculating the unique isotopic ratios of bronze articles, lead glass, and glazes that contain lead, and comparing the results against those of each mine, it is possible to estimate the specimens' place of production.

Underwater archaeology

This term refers to archaeology that deals with sites and artifacts that are underwater. The methods used for research and excavation are greatly different from those used for terrestrial studies. Underwater archaeology is intimately associated with diving technology, and is also linked to the evolution of the equipment needed for investigations. This discipline only began to flourish in earnest around 1960, when researchers from such countries as the US and France investigated archaeological sites on the ocean floor and surveyed sunken ships. In Japan, the Tsuzuraosaki underwater ruins at the bottom of Lake Biwa were discovered by accident and led to full-scale excavation. An example of full-fledged underwater archaeology, involving the creation of bathymetric charts and measured drawings, and photography and recording by underwater camera, is the excavation of the wooden battleship at the bottom of the harbor in Esachi City, Hokkaido that was embarked upon in 1972.

Radiography

Because x-rays are transmitted through objects and can sensitize film like visible rays, they can be used to observe the internal structure of archaeological artifacts much in the same way as x-ray diagnosis in the medical setting. By applying the photography of cross-sections (x-ray CT) and image analysis, it is possible to obtain x-ray images of even higher precision. In 1935, 40 years after their discovery, x-rays were used to look through the dry lacquer coffin that was unearthed from the Abuyama Burial Mound in Osaka Prefecture. On the other hand, radiography uses neutron beams. Since neutron beams are more easily transmitted through elements such as iron and copper than through elements such as hydrogen, oxygen, and nitrogen that compose organic matter, this method can be applied to look through metal containers and observe the paper and cloth articles inside.

DNA analysis

Deoxyribonucleic acid (DNA), which is the substance of the gene and controls the shape and properties of living things, can be extracted from dead creatures for analysis. DNA analysis of human bone can provide clues into the origins of humanity and its propagation, while DNA analysis of organisms can aid in the identification of species, seeds, or individuals. In this way, DNA analysis can be used effectively in the study of biological evolution and in estimating ancient growth and development conditions.

Plant opal analysis

Plant opals refer to microfossils of the glass-like cells found in the leaves of the rice plant and other plants of the family Gramineae. By measuring the plant opal content of soil, it is possible to obtain the total volume of rice hulls produced during the period in which a given volume of soil was deposited. However, it is difficult to identify the variety of rice from the shape of the plant opal. The establishment of this method of analysis allowed a new phase to be opened up in the research of the origins of rice farming. As a result, dramatic advances were made in the area of research relating to the origins and propagation of rice paddy farming.

Introduction to the Conservation Science Laboratory

Conservation Science Laboratory
National Research Institute for Cultural Property, Nara

Introduction

This Conservation Science laboratory conducts the basic research on the conservation of excavated objects and archaeological site, and is doing development research of new conservation techniques and materials. This laboratory has already developed and applied conservation techniques such as the vacuum freeze-drying method for waterlogged wooden-tablets, impregnate the archaeological sites with consolidants using decompression technique, the resin film method for soil-section peeling, the super water absorbent polymer method for cleaning patina from gilt objects; these techniques have been widely applied in other fields.

This laboratory has taken close cooperation with the archaeological excavation site of the *Heijo Palace*, being in charge of the removal of fragile objects encountered in the investigations, the transcription of soil sections of archaeological sites and the preservation of those features, and the chemical analysis, radiography, and the conservation of excavated objects: wood, metal, stone, glass and so on.

Further, in terms of relations with outside organizations, guidance and advice are provided regarding the conservation of excavated objects throughout the country, while training programs in conservation science are conducted for excavators belonging to regional public organizations, and recently, training and cooperative research is also being conducted in relation to various foreign countries.

1. Conservation Science and Restoration for Field Work

Removal of fragile objects by using Polyurethane Foams

Archaeological fragile objects at excavation fields are removed from the site using polyurethane foam, liquid nitrogen and other materials, are brought to the laboratory, and then applied conservation treatment.

Taking out by using polyurethane foamsand LN_2

Consolidation of Stone in Field

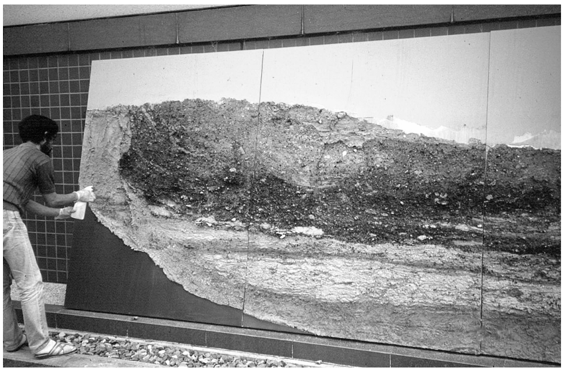
A great number of foundation stones and platforms are excavated at *Heijo Palace Site*. Among them, weathered Tuff are impregnated with organo-silicate (OH-100 Wacker) for consolidation.

Consolidation of stone with silicon resin

Sampling of Soil-Section by Resin Film Methods

One of the most important activities in archaeological excavation is documentation of profiles of strata. The important soil-section is peeled off the surface by the use of epoxy resin or modified polyurethane resin.

The peeled-off layers (resin film based soil section) are displayed in the museum.



Conservation treatment for Soil-Section

Sampling of Soil-Section by epoxy resin method

Detection of deterioration by using thermography

Measurement of thermal imaging

In order to investigate deterioration damage parts of historical buildings, monuments, stone statues and etc., temperature distribution is measured using thermography in the fields.

Application of Fiber-scope - Observation of the chamber in the tumulus -

Observation of the chamber in the tumulus

Before excavation of the tumulus, environment research is executed, such as temperature, humidity and air composition. Furthermore, using fiber scope, they are investigated what kind of objects they are, their deterioration conditions and their distribution inside the chamber.

2. Examination before conservation and restoration

Analyses of Archaeological Objects

Inorganic Objects

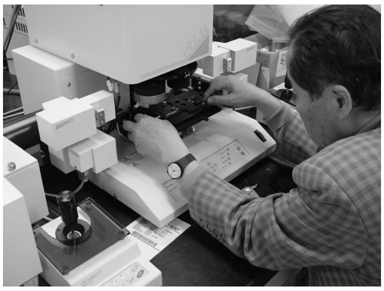
In order to know the material and the degradation of archaeological objects, observation and analysis are performed by various methods. An X-ray fluorescence analyzer and an X-ray diffractometer are essential equipment for the analyses of inorganic objects.

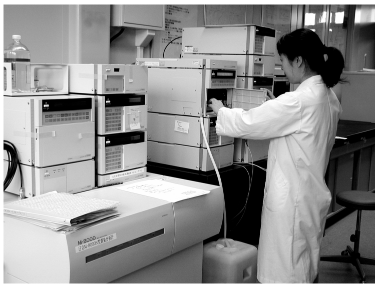

ND-X-ray Diffraction Analyzer


Non-Destructive Analyzer

Organic Objects

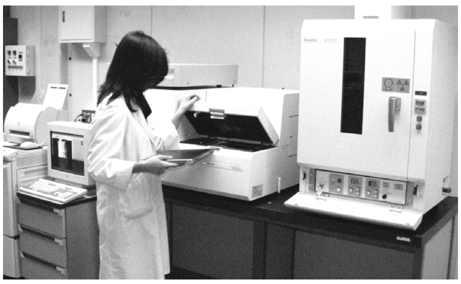
Many kinds of organic objects are excavated from sites. Conservation scientists use FTIR spectroscopy, fluorescence spectroscopy, LC, and so on.


FTIR Analysis


Liquid- Chromatography

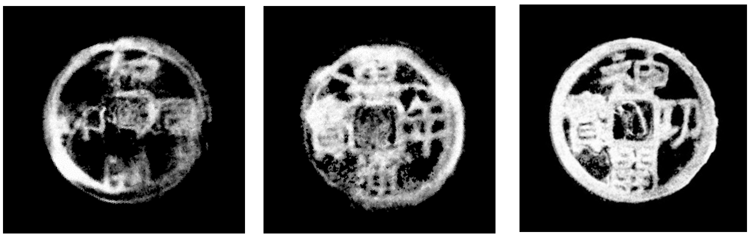
Radiography

The radiography is an indispensable nondestructive testing in the examination of archaeological objects to the conservation and restoration. Recent progress in digital imaging technology has led to the widespread application of X-CT (computed tomography) and CR (computed radiography), etc.


CR：Computed Radiography

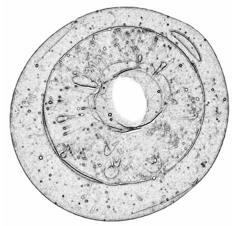

Film-based X- Radiography

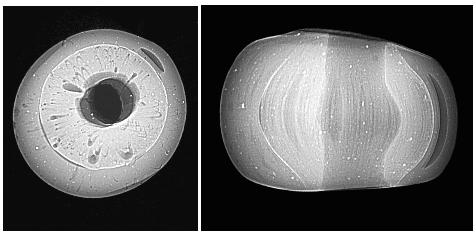

HiX- CT　Scanner



X-ray CT Image

Gold foil glass bead (5mmφ)



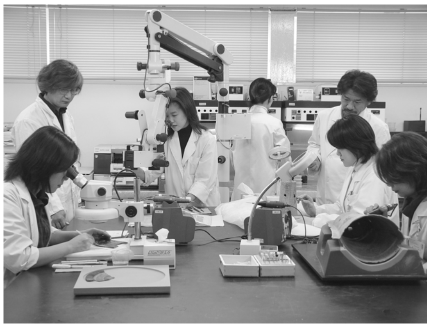


CR X-Computed Radiography

3. Conservation treatments

Conservation of Metal Objects

Metal objects covered with corrosion products with salt have to be treated for the cleaning and the desalination. The green corrosion products removal method using a super-water-absorbent polymer was developed in order not to damage the surface of the gilt objects. After the desalination, metal objects are impregnated with resin for preservation.

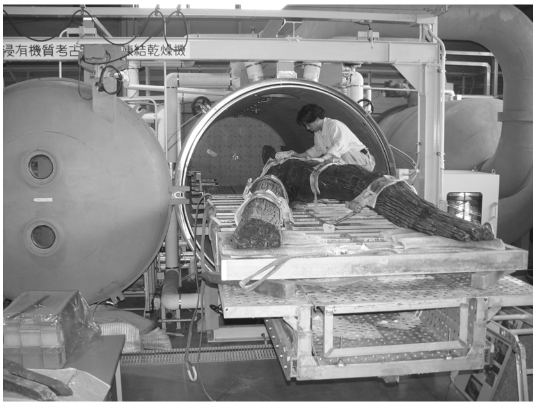


Removal of corrosion product by mechanical method

Conservation of Metal Objects

Conservation of Organic Materials

Organic objects such as wooden tablets and Japanese lacquer (Urushi) ware are treated by polyethylene glycol (PEG) impregnation methods, vacuum freeze-drying methods, and higher alcohol methods.



Vacuum freeze-drying method

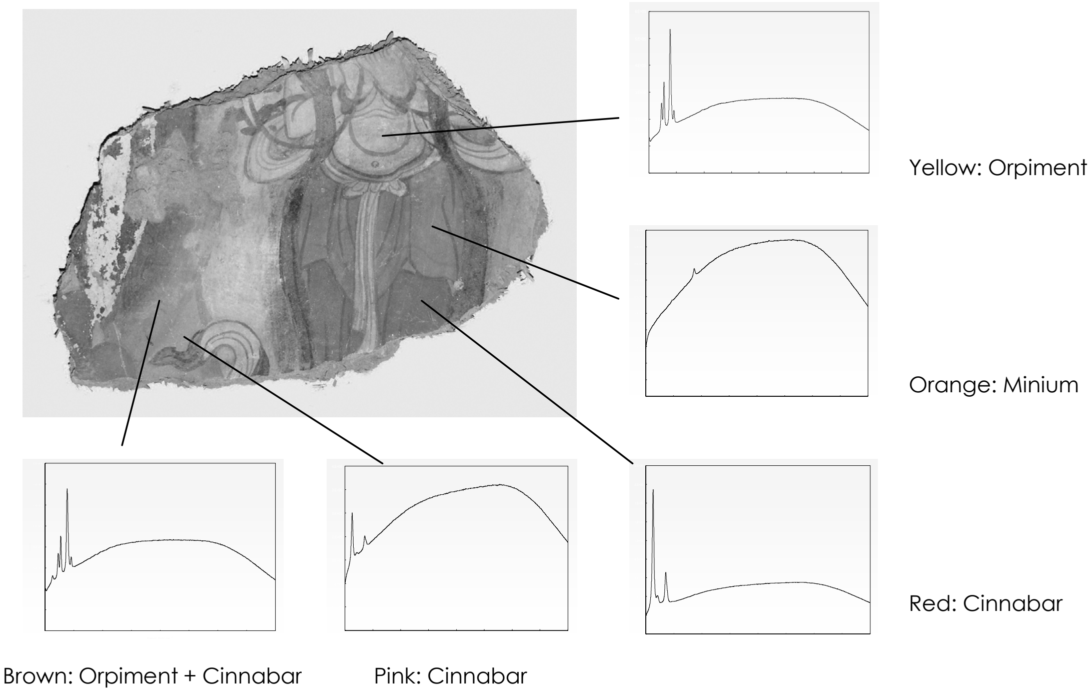
Higher alcohol method

PEG method

4. Non-Destructive and Non-touched Analysis of Archaeological Objects by Using Laser Raman Spectroscopy

It is possible to identify material from Raman spectrum of substance obtained by laser Raman spectroscopy. This analytical method has the characteristics as followed; 1) using visible laser in excitation, 2) no problem of water, 3) lower power of laser because of the high sensitive CCD, and 4) non-touched method. Laser Raman Spectroscopy is a non-destructive and non-touched analysis as well as high sensitive analysis.

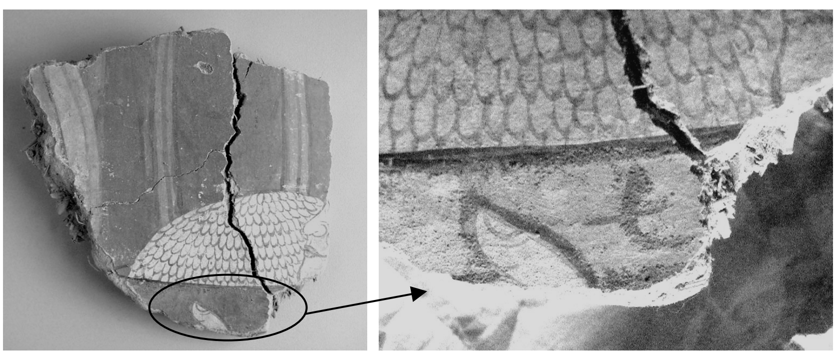
From the pigments analysis of mural painting piece of Da-Zhong Si temple stored in Huhhut Museum, China, yellow was identified as orpiment, orange minium, red and pink cinnabar, brown was mixtures of orpiment and cinnabar.



5. Infrared Reflectgraphy

Objects absorb a specific wavelength of radio wave. The other range of radio wave are reflected or transmitted through the objects. Visible rays is included a kind of radio wave, and the range is between 380 nm and 780 nm. Normally, we could see them. Objects absorb and/or reflect infrared rays, however, we could not see infrared rays by unaided eyes. Using this property, we could get invisible information. This is infrared rays reflectgraphy. We have two means to get some information by the method: taking photographs with films or watching monitor picture by infrared rays video camera. Recently, we could buy digital camera with the function of infrared rays reflectgraphy on the market. So, investigation has become easier.

It was the first time that infrared rays reflectgraphy was used to investigate the pattern of wall painting at Horyuji-Temple in 1936. After that, researches have been made on paintings or wall paintings by this method. Lately, infrared rays video camera has new device for adjusting clearness of images, so it is possible to make better investigation on unclear letters with Chinese ink or paintings. Especially, this method is useful to letters with Chinese ink on wooden tablets, we can find them even if they are almost impossible to read by unaided eyes.



Wall painting of Da-Zhong Si temple, Huhhut, China

Study Report on Cultural Heritage Conservation in Japan

DU Xiaoli (杜 暁黎)

Hohhot Museum

From November 17, 2004, I was invited by the Asia/Pacific Cultural Center for UNESCO (ACCU, Nara, Japan) and studied in Japan for 35 days at the University of Tsukuba, Nara National Research Institute for Cultural Properties, University of Nara, and Kashihara Institute of Archaeology. During over a month of studies, I learned the theories of conservation science and conservation techniques. My training in both academic and practical fields was much improved. I sincerely appreciate the ACCU for providing me with such a valuable opportunity to study under the supervision of Japanese experts and professors. I am very grateful for their professionalism and kind cooperation. My study in Japan basically focused on the following two aspects: 1) comprehensive knowledge of conversation science for cultural properties, 2) technical training of conservation science.

Comprehensive Knowledge of Conversation Science for Cultural Properties

Even though I had some practical experience on the repair of mural paintings, I had not had time to concentrate on improving my comprehensive knowledge of conservation science for cultural properties. During my study in Japan, I learned and reviewed this subject including its theory, history, and techniques.

Japan has a history of over 100 years in studies of conservation science. In the administrative area, Japan initiated its first law for cultural artifacts in 1871, the Law for the Preservation of Antiques and Old Properties. In 1897 and 1929, the Protection Law for the Old Shrines and Temples and The National Treasures Preservation Law were adopted. In 1950, the Law for the Protection of Cultural Properties was enacted, and this legislation synthesized existing regulations and orders concerning the properties into a comprehensive system. In the academic field, the art critic Tenshin Okakura in Meiji times emphasized the importance and beauty of traditional Japanese culture. He brought great contributions to the restoration of Japanese pictorial art (Nihonga). Due to his efforts, in April 1916, natural science techniques were applied for the first time in Japan for the conservation and repair of the mural paintings of the Kondo (Golden Hall) in Horyu-ji Temple. In the past decades, studies on conservation science for cultural properties in Japan have been intensively developed, particularly in the fields of material analysis, conservation environment, and techniques. Conversation science for cultural properties has become a subject that closely combines social and natural sciences. The Japanese achievements in studies and techniques have provided important support for protecting cultural assets in Asia and the world.

What are cultural properties? Why should we protect cultural properties? How can we conserve cultural properties properly? It is impossible to protect cultural properties properly without a clear understanding of these fundamental concepts. Dr. Masa'aki Sawada, the professor of the University of Tsukuba, had explicit answers. He stated that "cultural assets are the cultural heritage that ancestors created and left to us. They are valuable human information, which should be retained for the future. Cultural assets not only inform us of the lives of our forefathers but also can be an orientation for our creating the future. To conserve the cultural properties, fundamentally, is to gestate the energy for building a new culture. Its assistant actions are conservation and repair." This clearly indicates the essence and definition of conservation for cultural properties. In his "Scientific Methodology of Conservation," Dr. Sawada points out that, "studies for conservation science...must respect the tradition while using the newest high technology. To study the materials and conformation of cultural properties is to evaluate their information value; to study the conservation environment is to preserve and manage; to repair cultural properties is to keep their original condition. It is very important to apply the methods of natural science to developing repairing materials and techniques in conservation science." After discussions with Japanese experts, I am much clearer about the essence of cultural heritage and the purpose of conservation. When visiting Tokyo National Museum, Hirasawa Administrative Palace and Gango-ji Temple, I deeply felt that Japanese scholars and experts have the same understanding about the ideology of conservation in both the theoretical and practical fields.

1. The ideology of conservation and restoration at the National Museum of Tokyo

We observed how the experts restored Japanese silk paintings and paper ink paintings in the museum. They stressed that we should avoid changing the current condition of objects when antiques are in the process of conservation. For the repairing and restoring of antiques, the simpler the better. The most important is the conservation environment. The museum has two primary tasks in the conservation of cultural properties: one is to protect their environment; the other is to deal with emergencies.

2. The model of conservation and repair for the Hirasawa Administrative Palace

The construction of Hirasawa Palace has been destroyed. In the site, the same materials were applied in demonstrating the original construction. Because the way in which the materials were applied in the original construction is still unclear, three types of roof using tree bark, dried straw and wooden boards are illustrated. The restored construction is placed over the original site at least 30 centimeters above it. Not only does this model of conservation keep the current condition of the site effectively, but it also displays analyses of how the materials were possibly used in the original construction.

3. The techniques of conservation and restoration in the Gangoji Institute for Research of Cultural Properties.

In the institute, we viewed the process for restoring and repairing painting pigments of carved wooden sculptures of Buddha from Sitsumura Times. Since the sculptures have been painted again in Meiji times, they needed to be stripped until the original paintings appear. Then the sculptures can be reinforced and restored. There were various glues made from cow bone, rabbit hide, and other animal resources, which can be used on varied occasions. For instance, the glue used to reinforce the sculptures of Buddha was from cow bone. The production of cow-bone glue also adopted traditional techniques. Thus, as antiques are repaired and conserved through traditional materials, traditional techniques (as an intangible cultural property) can also be saved.

Throughout the discussions and observations, I further understood the meaning of conservation for cultural properties and the importance of its methodology. It seems more important to learn the way that people think.

Technical Training for Conservation Science

As alluded to above, the choice of methods and the use of techniques in conservation determine the value and life of cultural assets. While learning evaluation and conservation, we focused on studies of how to survey and analyze the current condition of the cultural properties. The programs also provided onsite practical training.

A key point is to make accurate research and analysis for conserving the items. For instance, in the case of conserving tumulus paintings, the paintings can be either kept on the site or removed for conservation. These two methods will be applied to different situations based on the condition and environment of the tumulus. Prior to the actual conservation, onsite research and investigation are very important. During the process of research on the tomb structure, interior conditions and exterior environment, non-damaging methods must be employed. After analyzing all the information, the proper techniques will be applied. Mr. Kohdzuma gave us an appropriate example about the conservation of cultural properties in his lecture. Cultural properties are like patients, and we are like doctors, he said. A doctor must diagnose his patients carefully, find the cause of the disease, and decide methods of treatment. However, we have not paid enough attention to this part in our work of conservation, and we need to improve survey and research before the practical conservation in the future.

In the Nara National Research Institute for Cultural Properties, we observed the newest apparatus of detection that are safe for the objects and leaned how to operate them. Some of them have been used for probing the materials of grottoes in Xingjiang and the murals of the Da-zhao Temple in Hohhot city. Using advanced technology will help us get accurate information and promote the efficiency of conservation.

The onsite training program has improved my technical skills. At the Nara Palace Site (Heijo-Kyo), we participated in the training of rescue excavation of artifacts. To uncover the stratum of earth is a complex process because many factors (surroundings, temperature, quality of soil, conservation materials, techniques, and personal experience) affect the final result. We realized the importance of recognizing the character of protective materials for cultural properties.

Environmental pollution and the change of temperature and moisture can make a big impact on antiques. Under the supervision of Mr. Nishiyama, we visit ten sites where pollution monitors are set up in order to inspect the influence of the environment on cultural properties in Nara. We tested and analyzed some samples from the sites such as stone, wood, metal, mural pigments, paper, glass, dyed fabric, etc. After the experiment, I became more aware of the details of the relationship between the environment and cultural properties.

My study in Japan has broadened my academic view. More importantly, it has enriched my ideology about cultural properties and conservation science. Conservation science for cultural properties is not an isolated subject. It must be regarded as a whole that involves social and natural science.

Inner Mongolia has numerous unique cultural assets since different ethnic groups have inhabited this area. However, the conservation of cultural properties has not been performed as well as it should have been. Besides the deterioration from the natural environment, the lack of experts in the field and the weakness of techniques have limited conservation work in cultural properties. In addition, we also face many challenges including monetary shortages, the lack of public education, and a deficient administrative system. Many cultural assets are in a serious condition such as the tomb paintings of the Khitan (Liao Dynasty), the temple murals of Tibetan Lamaism and grotto murals. As a researcher and administrator in the museum, it is my responsibility to use effective methods to preserve our cultural assets properly for the future generations. There are numerous issues that need to be reconsidered and further explored. For example, how to evaluate our conservation achievement so far? What principles should be set up for conservation of cultural properties based on our situation? How should we protect our cultural heritage properly under the current economical and technical conditions? How should high technology be properly used in conservation? How should we discover and utilize our traditional techniques? While we continue to strengthen academic and technical communication with other countries, we need to establish and develop our own conservation theory, science and techniques with respect to Chinese culture, tradition and reality.

文化遗产保护调查修复个人研修报告书

内蒙古自治区呼和浩特市博物馆
杜　曉黎

2004 年 11 月 17 日，我应亚洲文化中心文化遗产保护协力事务所的邀请，参加了为期三十五天的赴日研修学习。我在筑波大学大学院、奈良文化财研究所、奈良大学、橿原考古学研究所等相关文化财保存科学的科研院所，亲耳聆听世界一流的文化财保存科学的专家和学者们讲课，并在他们的指导下学习科学保存修复技术。无论是指导老师深入浅出的理论阐述，还是遗迹现场的参观实践，我都深刻地感受到这次学习机会的难得和宝贵，感受到文化遗产保护协力事务所(奈良所)对我们的研修学习所付出的心血和努力，以及国际间共同为保护人类文化遗产所作出的贡献。在这短暂的一个多月里，我从保存科学的基础理论、保存修复的材料、保存环境、保存修复技术等诸多方面，得到了全面而系统、深入而细致的指导与学习；从知识到技能，都得到了良好的培养和训练。我的学习收获可以归纳为以下三点：

一、　文化财保存科学的认识
二、　保存科学技术操作实践
三、　参观重要文化财的感受

一、　文化财保存科学的认识

在文化财保存科学基础理论知识的学习中，我不仅对日本文化财保存科学的起源、发展历史、以及在当今世界保存科学领域中所取得的令人瞩目的研究成果，有了全面系统的了解和认识，而且进一步明确了文化财保存科学的目的、意义，以及保存科学所涉猎的范畴和方法，同时结合我们地区文化遗产保护的具体情况，有了更加深刻的体会。

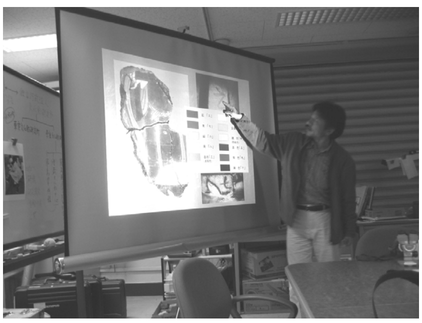
日本对保存科学的研究，已有百年的历程。从１８７１年日本第一部有关文物保存的条例“古器旧物保存法”、１８９７年“古社寺保存法”、１９２９年“国宝保存法”的发布、到１９５０“文化财保护法”的修订；从明治时代美术评论家冈仓天心先生的倡导和１９１３年法隆寺金堂壁画的保存 到保存科学的机构设置 研究体系的确立、

研究范畴的开拓延伸，文化财保存科学逐渐形成融合自然科学、人文社会科学、跨学科的学术领域。近十几年来，日本文化财保存科学的专家学者对于材质研究、保存环境研究、保存材料、保存技术的研究，都达到了世界领先水平，为世界文化遗产保存，特别是亚洲地区文化遗产保存提供了科学的理论和先进的技术支持。筑波大学大学院的沢田正昭先生认为“文化财是由祖先所创造而留传至今之文化遗产，由过去传至现在，更应由现在留存至未来的珍贵人类信息。从中不仅可以了解祖先的生活，也可成为人类创造未来的指针。保存文化财，加以广泛应用就是孕育创造新文化的能量。其辅助行为就是文化财之保存与修复”，他的论述非常精辟，使我更加深刻地认识到文化遗产保护的意义和重要性。他在“保存科学方法论”中明确指出“（保存科学研究）……既尊重日本古有之传统，又采用最新之高科技进行研究。研究其材质构造是为了判断文化财资料的价値；研究保存环境是为了保存管理、修复文化财以维持文化财资料的原貌，并运用自然科学方法来研究开发修复材料和技术”，高度概括了保存科学研究的宗旨和内涵，使我进一步明确了保存科学研究的目的和方法，得到了启迪。

内蒙古自治区，文化遗产资源十分丰富。草原民族创造了绚烂多彩的历史文化，以其独特的民族地域特征成为中华民族珍贵的历史文化遗产。然而，由于地理条件和环境气候的劣化，尤其是文物保护人才的严重缺乏和保存技术的薄弱，文化遗产保存受到严峻挑战，一些重要的文化遗产的保存状况病害严重，诸如辽代契丹墓室壁画、明清西藏佛教（喇嘛教）寺庙壁画、石窟壁画等等。我们所面临的重要问题在于培养文化遗产保护人才，学习先进的科学理念和保护技术。这次研修学习，对我们来说，无疑是雪中送炭。在学习过程中，随着老师的引导，我的知识的触角，也在向保存科学领域的纵深探求，深深地汲取了知识的养分，丰富了我的头脑。这些，都必将促进我们的工作和事业的发展。

二、保存科学技术操作实践

奈良文化财研究所在进行遗物光学的观察和分析及遗物保存修复材料的课程讲授中，结合发掘实地遗物保存技术的操作训练，不仅给我们留下了极为深刻的印象，而且通过亲手操作，技能有了提高，体会更加深刻。特别是肥塚隆保先生讲述的“古坟壁画的保存科学研究”和高妻洋成先生关于“壁画颜料褪色的分析”，对我正在进行的壁画保护修复和以后的墓葬壁画保护有很大的启发和重要的指导意义。



１、调查分析

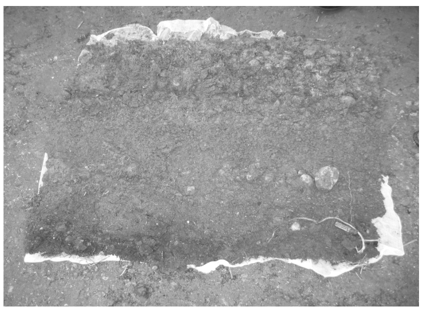
文化财保存科学方法重要的一环，是对文化财的调查分析。授课的老师都特别强调了这一点。例如对古坟壁画“就地保存”还是“揭取保存”，是两种不同的保护方法，预备调查就显得尤为重要。首先采用非破坏性的调查方法，对古坟构造、石室内部保存状况、内部环境进行调查，然后决定揭与不揭；其次是对保存环境的研究、材料科学的研究、壁体构造的研究、保存修复的研究。每一项研究都离不开复杂细致的调查。高妻洋成先生谈到“文化财保存方法”时也一再强调调查的重要性。他举了一个很贴切的比喻，说“文物是病人，我们是医生，做的是医生的工作，就要调查、诊断病因，这是最重要的，关系到药物、药量的配制。根据病状，决定治疗的方法。通过诊断、治疗，才能使文物从劣化状况转为安全状况。”回顾我们的工作，往往忽略的恰恰是事先的调查，或者说是不够细致的调查，这就是差距和不足，需要在今后的工作中，尽可能地做到弥补和改进。

在奈良文化财研究所，我们看到了许多用于非破坏测定的先进的科学仪器，老师们详细地介绍了这些仪器的性能、用途和使用方法，其中有的仪器在新疆石窟壁画的测试和内蒙古大召壁画材质测试中使用过，这也使的我们对今后国际间的交流合作更加充满信心。我们同样希望在文化遗产保护中，能够借用这些先进的技术，提高我们的文物保护修复水平，促进文化遗产保护科学的繁荣发展。

２、操作实践

在平成宫迹发掘现场，我们参加了地层揭取出土文物应急处理的操作训练。

考古发掘现场的地层揭取，其意义重大，也是文化财保存科学方法中的重要手段。地层揭取的操作过程看似简单，其实包含了环境调查（大气环境、地层表面环境）、材质调查（黏土、沙石），不同的土质，对温度的吸收也不同。在涂刷聚乙烯树脂和粘贴纱布的时候，既要掌握技术要领，又要凭感觉和经验，才能揭取成功。老师的耐心指导和积极鼓励，成为我们努力学习的动力。对于考古发掘现场出土文物的应急处理，是考古发掘中经常遇到的情况。奈良文化财研究所对岛根县现场出土的３５８柄铜剑和飞鸟藤原遗迹水落系统的成功搬运，使我们从理论上有了认识；



现在经过现场实践，使用不同的材料和方法，包括发泡树脂、液体氮、管道胶带的使用，的确大大提高了我们的理论知识和实际操作技能。

具有特殊意义的是，我们和伊拉克、阿富汗国家博物馆保存科学的同行们一起进行了地层揭取训练。大家都非常投入，认真而专注地完成每一个步骤。虽然我们无法用语言沟通，但每一张友好真诚的笑脸，和共同保护人类文化遗产的信念和责任感却是相同的。当伊拉克的朋友说，学习结束回国后要和伙伴们一起抢救伊拉克的文化遗产，为文化遗产保护努力工作的时候，我们祈求人类不再有战争。

在奈良大学环境保存科学研究所，我们在西山要一先生的带领下，对奈良市十处重要文化财环境监测点的监测仪器进行了置换，并且做了污染测试的资料分析，其中包括石造、金属、木造、壁画颜料、纸、玻璃、染织品等种类的文化财。了解、认识了大气环境污染和温湿度变化等因素对文化财保存造成的影响和损坏，增强了环境保护的意识和对保存环境研究的重视。

三、参观重要文化财的感受

研修课程中的另一部分内容，是参观重要文化财（遗迹、遗物）、文化财保存科学研究所设施和博物馆陈列展示，使我们身临其境，更加直接地观察一些保存科学的设施、保存修复的过程和保存修复的效果。并且针对一些具体物件的修复材料、方法等问题及时地进行了交流。

⑴东京国立博物馆的保护修复理念

东京国立博物馆每年大约要修复 150 多件文物，其中二分之一的书画作品是在本馆完成。馆里有两个研究室：一，环境保护室，主要研究展室和库房环境。二，保存修复室，主要做保护修复计划。

在书画修理室，我们参观了采用传统工艺和传统材料修复的日本绢画和纸质水墨画。应急处理室，则主要修复一些急需保护处理的文物包装，如匣、袋等，对文物本身并不修复。他们强调修复前要调查文物是什么材料，弱的地方是什么，强的地方是什么，弄清楚了，再开始做。他们认

为对文物的修复越简单越好，尽量要少动文物，不要过多地干预文物，保存环境是最重要的。一是要保护环境，二是要应急处理，这是博物馆的重要项目。这些都是非常值得我们学习借鉴的，目前我们大多数博物馆还没能做到有计划地进行文物的保护修复，基本上是抢救性的保护修复。因此，有必要做好馆藏文物调查，了解掌握每件文物的现状和性质特征，根据保存情况制定出保存修复计划。

⑵平沢宫官署遗迹的保存修复形式

平沢宫官署的地面建筑已经全部毁坏，因而无法断定它的材料，所以在复原中采用了三种屋顶的形式：木板、茅草、桧皮。遗迹部分的地基用矮木桩显示，建筑的屋内面积和屋檐部分用不同种类的草来分界，结缕草表示屋内，单束草表示屋檐，一目了然。在复原建筑的下面，和原建筑的地基之间，最少有３０公尺的隔离层，很好地保存了古代遗迹。这种对古代建筑遗迹的保存复原形式，不失为一种科学理性的选择。

⑶元兴寺保存科学研究所保存修复工艺

平沢宫官署遗迹

在元兴寺保存科学研究所，我们参观了木雕佛像的保护修复，主要是彩色脱落的修复，加固和回贴。先要把明治时代重绘的色彩去掉，露出里面室町时代的彩绘，然后进行加固和回贴。采用的加固剂是牛骨胶，而且是用日本50年前的传统工艺熬制，因为这样会有大量油脂。也有中国的工业用胶（硬，基本不用）和水牛熬的胶，兔皮熬的胶，成分和性质不同，根据材料的需要选用。他们的修复工艺不仅采用传统材料，而这种材料也是用传统工艺制成的，这种严谨的科学态度，使我深受触动。以往，我们注重的只是材料的性质、性能，而对它的产地、制作工艺却知道的很少。通过学习，我们获得了新的理念和先进的科学技术，建立了友好密切的关系，为文化遗产保护的交流合作奠定了基础。

研修学习就要结业了，我的所学、所见、所闻、所感、所获，很难用短短的篇幅全面地表达出来，但我所汲取的知识的养分，必将滋润我们的事业，那些给我帮助、与我相处的老师、朋友必将永远留在我的记忆中，并将激励我努力工作！

再次向所有的老师和朋友们表示由衷的敬意和深切的感谢！

二００四年十二月二十日

Report

WANG Qi (王 琦)
Cultural Heritage Protection Department
Cultural Heritage Bureau of Xinjiang Uighur Autonomous Region

My visit to Japan was a valuable and unique research opportunity, since Japan is at the top level globally in the field of cultural heritage conservation science. What makes Japan the top level in this field is the philosophy behind the preservation of cultural heritage and the establishment of a conservation science system, not to mention the advanced equipment and techniques used to preserve Japan's cultural heritage.

Although my training period was short, I was able to gain a wide range of knowledge in a short period, thanks to well-organized lectures and allocation of time. The topics I studied included the basics of conservation science, conservation of stone cultural properties, pigment analysis of ancient murals and their preservation environment, study of material analysis of cultural properties, and restoration materials and preservation environmental survey of cultural properties.

In addition, I had the chance to visit and observe diverse heritage and conservation facilities, including numerous world heritage sites, important cultural properties, museums and research institutes for cultural properties. In particular, I gained an understanding of and was deeply impressed by the practical protection of cultural properties in Japan through my participation in peeling a stratum and the first-aid treatment of relics on the spot at the National Research Institute for Cultural Properties, Nara.

In China's process of preservation, lack of professional engineers and facilities has resulted in laissez-faire and crude preservation measures for cultural properties. In some cases, we have actually damaged them. During my stay in Japan, while attending lectures by specialists, I came to understand that cultural properties need to be protected according to scientific procedures. More specifically, minute chemical analyses need to be implemented to determine which conservation method is best applicable. First, it is necessary to analyze the material composition and structure of the target remains, and then their physical and chemical properties must be identified. Actual restoration and conservation can be started only after gathering all these pieces of information. A conservation method is selected based on observation and analysis according to these procedures. I understood that material analysis of cultural properties is the basis of technical research on cultural properties from the view of conservation science.

Relics are composed of different materials, and weathering of these cultural properties starts with degradation of materials. Accordingly, it is essential to first identify the base materials and element composition of a cultural property, its chemical structure, and the properties to allow preservation of its quality and prevent natural destruction or slow its rate of degradation. Mechanisms for qualitative changes in materials need to be studied, and measures against degradation and changes in properties must be taken using techniques and treatments for preventing qualitative changes.

For example, with respect to the protection of murals, I learned the following points at the National Research Institute for Cultural Properties, Nara. When chemically analyzing the materials of murals, it is also necessary to include a pigment analysis and materials analysis of the wall behind the painting in the survey. These surveys allow us to understand the secular changes in and deterioration process of the material. In particular, it is necessary to understand whether the currently visible pigment is the original pigment or the deteriorated pigment. This is an extremely important key to the future conservation and restoration of murals.

Through the training I underwent, I gained the understanding that data collected by analyzing cultural properties using contemporary scientific techniques and methods has important informative value also in studies of technology history, technical art history and archaeology. Moreover, these pieces of data provide objective grounds for the scientific restoration of cultural properties. Protection of cultural properties is, in fact, the protection of materials. Analysis of material properties is thus the basis of scientific technology in the protection of cultural properties. I have observed diverse analysis apparatuses at the National Research Institute for Cultural Properties, Nara. The apparatus to be used for analysis differs according to the target cultural properties. In particular, I was deeply impressed with fluorescent X-ray spectroscopy in non-destructive analysis methods.

At this stage, the methods applied to the protection of cultural properties in Xinjiang-Uighur lag far behind world standards. We lack the facilities needed to protect our cultural properties. Even in the whole of China, I think only a few research institutes for cultural properties and large museums have facilities like the ones I saw in Japan. When I return, I hope to actively promote cooperation among research institutes of cultural museums and science research institutes. I expect that we will be able to analyze cultural properties by fully providing advanced facilities to these research institutes, fostering scientific specialists, encouraging the provision of abundant scientific information, and making use of social scientific technology.

Recently, facilities applicable to the protection of cultural properties are becoming increasingly advanced, driven by improvements in the general standards of scientific technology. Japan leads the world in this field. Before I came to Japan, I had heard that Japan has extremely advanced facilities. I was impressed that the National Research Institute for Cultural Properties, Nara, stresses not only the importance of applying the latest scientific technology to the protection of cultural properties, but also of traditional survey methods. I was quite impressed that they are also paying attention to storage methods after conservation treatment.

For example, with regard to the excavation of tombs, we in China start excavation without thorough preparations. Accordingly, relics are not protected from exposure to the air. In Japan, on the other hand, a preliminary survey is always conducted. The excavation of Takamatsuzuka Tumulus is a very good example. To identify the structure of the tomb, experts used a wide range of tools for surveying the conditions of geological layers and fiberscopes for examining the inside. Information such as the air content inside the tomb was also collected. A covering hut was then built around the site to maintain the humidity and temperature inside. Only then was the Takamatsuzuka Tumulus excavated. These preparations allowed the relics in the tomb to be kept in good condition.

I believe this approach would be effective for us. At the new No. 1 and No. 2 caves of Kumtura Thousand Buddha Caves, Xinjiang-Uighur, the external environment is extremely bad. We also built a hut around it, but the temperature and humidity are not controlled, allowing the temperature and humidity inside the caves to change according to external changes. These are extremely unsuitable conditions for protecting murals. From now, I would like to refer to your approach applied to the Takamatsuzuka Tumulus, and use scientific methods to protect these two caves.

During my stay in Japan, I was able to gain a systematic understanding of the advanced conservation and restoration of cultural properties. In other words, I am now fully aware of the need to implement a preliminary survey before restoring cultural properties. Relics are first surveyed and analyzed by eye or by devices from the viewpoint of archaeology, art and history; and then a conservation and restoration plan is prepared based on the gathered information. Lastly, the environment is stabilized and deterioration halted to preserve and manage the relics.

I am now aware that there are various measures and materials applicable to the protection of cultural properties in Japan. Conservation materials and methods applied differ according to the type of cultural property. The degree and rate of deterioration is also diverse, depending on the materials and the buried environment of the cultural properties. Selection of materials for conservation also becomes complicated. In other words, it is necessary to consider the condition in which the relic has been found when selecting the materials. If no appropriate material is selected, no sufficient effect can be expected. This means the historical significance and other values of the cultural property cannot be sufficiently protected.

I understand the need for selecting appropriate conservation materials from those available by identifying the materials comprising the cultural property, the degree of damage, the ambient environment and the specific value of the cultural property to be protected. Selection of materials used for conserving cultural properties is the key to conservation, and appropriate selection immediately and directly affects the protection results. Just as different medicine is dosed depending on the state of disease, there is an appropriate conservation material depending on the state of damage of the cultural property.

Dr. Kohdzuma taught me that we are doctors and cultural properties are patients. In other words, our work is same as that of a doctor. We interpret causes based on the state of disease of a cultural property, and a remedy is provided according to its specific disease state. Accordingly, it is necessary to make a comparative judgment for careful medication after identifying the value of the cultural property, material, type of disease, structure of disease, cause of disease and surrounding environment, and (fully considering every aspect of the properties) of the conservation material and application methods. When I return, I plan to put my efforts into applying this philosophy to my future work, promoting technical cooperation between experts in the protection of cultural properties in Xinjiang-Uighur and the National Research Institute for Cultural Properties, Nara, and fully utilizing a range of materials developed at the National Research Institute for Cultural Properties, Nara so that protection of cultural properties in Xinjiang-Uighur becomes more scientific.

This time, I was able to gain an understanding of restoration measures to some extent as well as the diverse facilities and equipment used in the protection of cultural properties in Japan. I also had the opportunity to learn about storage methods after restoring cultural properties and methods of monitoring the environment of cultural properties inside and outside, under the instruction of Prof. Yoichi Nishiyama at Nara University. Environmental conditions for preservation differ according to the materials that make up cultural properties. Accordingly, the risk of further destruction of cultural properties is high if storage conditions after treatment are neglected.

In the case of cultural properties that are outside, the impact of air temperature, humidity and pollutant sources on cultural properties can be observed by monitoring and measuring the air environment, and thus solutions can be determined. I think this approach would be very beneficial for protection activities in Xinjiang-Uighur. There are iron foundries around the Kezier Thousand Buddha Caves in Xinjiang-Uighur. These plants have been emitting gases for many years, and have had a significant impact on the murals in the Thousand Buddha Caves. However, since we have not monitored the air environment and no scientific proof of the detrimental effects of the environment on the murals can be provided, this situation cannot be changed by the organizations related to cultural properties.

Through the lectures I attended, I became aware of the serious impact that air pollution has on our cultural properties. I learned the process of how different elements in the air damage cultural properties made of wood, stone and metal, and realized the importance of measuring the environment. From now on, we will actively measure the environment surrounding our cultural heritage to provide scientific evidence to the government authorities for determining strategies.

As a result of this training, I was able to gain an appreciation of the world's latest scientific techniques and measures for protecting cultural properties. I also became aware of the philosophy of the scientific approach to and the research system for protecting cultural properties in Japan. I also found a glimmer of hope in solving the problems I face in my daily work.

What I have learned in Japan will be useful in my future work, including the protection of murals, in particular the preservation of tombs and cave murals on-site; preservation of external cultural properties on-site; and preservation of wooden structures, stone structures and ancient ruins. More specifically, I will try to bear in mind the importance of adopting comprehensive methods where possible by further pursuing studies on cultural properties and conservation techniques from a scientific approach; carefully studying the properties of each cultural property and gradually deteriorating structures due to the influence of the environment; gaining skills in protecting and restoring cultural properties using scientific methods; and stressing the importance of selecting conservation materials, techniques and methods from a scientific viewpoint.

The training I experienced can be summarized as having provided me the opportunity to gain a massive injection of new knowledge and concepts. These will help me in my career in the protection of cultural properties. I also gained the opportunity to meet numerous specialists in the protection of cultural properties in Japan. When I return, I would like to step up exchanges and joint research projects between people involved in cultural properties in Xinjiang-Uighur and the specialists I have met here. I hope we can work together to protect the world's cultural heritage.

Lastly, I would like to extend my thanks to the Asia/Pacific Cultural Centre for UNESCO, the National Research Institute for Cultural Properties, Nara, Mr. Yasushi Nishimura, Prof. Masa'aki Sawada, Ms. Kayoko Ishii, Dr. Toshiya Matsui, Dr. Takayasu Koezuka, Dr. Yosei Kohdzuma, Dr. Junko Furihata, Prof. Yoichi Nishiyama and all the other instructors who spent time teaching me.

Nara, December 20, 2004

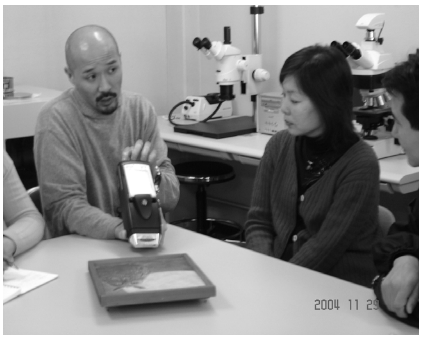
学习报告书

新疆文物局文物保护处
王　琦

此次来日本，对我来说是一次非常难得的学习机会，因为日本在文化遗产保存科学方面具有世界先进水平。这不仅体现在日本对于文化遗产保存所运用的大量先进设备与技术手段，同时，日本在文化遗产保存科学理念以及保存科学体系方面也具有世界先进水平。

虽然此次来日本学习的时间很短暂，但是由于日方在课程内容与时间上都作了经心安排，使我能够在短时间内学到很多知识。其中包括：保存科学概说、石造文物保存、古代壁画的颜料分析与保存环境、文物材质分析与修复材料研究、文化遗产的保存环境调查等等。同时，还参观了许多世界文化财、重要文物财、各种类型的博物馆、文化财研究所以及各种保存设备。尤其是在奈良文化财研究所学习并亲自操作地层的揭取及野外危急文物的保护工作，让我对日本文化财的保护工作有了更多的了解，并留下了深刻的映象。

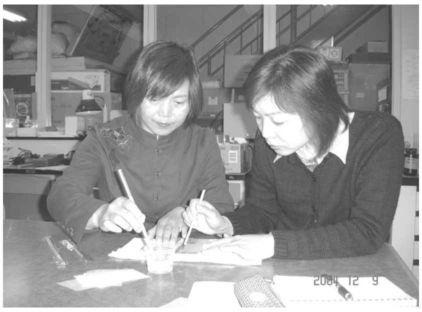
1、听日高老师讲课



2、松井老师介绍仪器设备

3、泽田先生授课

我们在以往的工作中，由于缺乏专业技术人员及设备，对文物的保护工作是简单而粗暴的，有的甚至还对文物造成了破坏。来日本之后，尤其是通过专家讲课，使我了解到文物保护工作是有一套科学程序的，即在任何的保护工作之前都要采取严格的科学分析。首先要了解其结构，其次是物理性，第三是化学性，掌握了这些信息后再进行修复保存，其过程是：观察→分析→保护手段。懂得了文物材质分析检测是文物保护科学技术研究领域的基本内容，一切文物都是由不同的材料构成的，而文物的自然损坏，则始于材料劣化。因此，想维护文物质量，阻止或缓解自然力的破坏，首先要查明构成文物的基本材料和劣化产物的元素组成、化学结构和物理性能，探索文物材料的质变规律，从而采取预防性技术措施，对抗劣化变质。比如，在壁画保护方面，我在奈良文化财研究所学到，首先要对壁画进行材料科学调查，包括颜料的调查、壁画壁体的材质调查等，通过调查了解材料的历史变迁、劣化过程，尤其是了解现在看到的壁画颜料是原来的，还是劣化后转变而来的，这对于壁画的后期保护修复是非常重要的。



4、作壁画修复练习

5、遗址的环境监测

6、大气污染元素分析

7、学习地层揭取

通过学习我了解了运用现代科学技术手段对文物进行分析检测，所取得的数据资料，对科技史、工艺史和考古学的研究皆有重要的参考价值，更是对文物进行科学修复的客观依据。因为保护文物的实质是保护材料，因此文物材料质地的分析检测是文物保护科技工作的基础。在奈文研我们看到了许许多多的用来进行检测的仪器设备，对不同的文物采用不同的设备进行分析，尤其是非破坏测定法即荧光 X 线分析法给我留下深刻映象。

虽然目前新疆在文物保护方面还很落后，缺乏必要的文物保护设备，在日本所看到的一些仪器设备在中国可能只有少数文物研究机构和大型博物馆才有。因此，回国之后我将积极推动文博界与科研机构的合作，充分利用这些单位的仪器设备先进齐全、科研人才实力雄厚、科技资讯丰富的特点，调动社会的科技力量，共同开展文物分析检测工作。

近年来，随着科学技术水平的不断发展，用于文化财保存方面的仪器设备也越来越先进，日本尤其在此方面走在了世界前列。来日本之前就听说日本在文化财保存方面有非常先进的设备，然而，在奈良文化财研究所我了解到，日本不仅重视科学技术在文化财保存方面的作用，而且更注重传统的调查方法和后期的保管工作，这一点也使我感触很深。比如对墓葬的发掘，我们的工作方式是直接进行发掘，使文物在未作保护的情况下暴露出来。而在日本是首先要进行调查，高松塚墓葬发掘就是一个非常好的实例，日本专家通过各种仪器了解墓葬构造、在地层中的位置以及通过装有探头的设备对其内部进行窥视，以便了解墓葬内部的情况，甚至包括墓葬内部的气体成份等信息，然后在墓室外加盖房子，进行温湿度的调控，最后再进行发掘，这样对墓葬内的文物才能起到更好的保护作用。这一方法是值得我们借鉴的。新疆库木吐喇千佛洞新 1、新 2 窟的外部环境非常恶劣，目前只是在洞窟外加盖了房子，还没有进行科学的温湿度控制，因此洞窟的气温与湿度随外界而发生变化，这对壁画的保护非常不利。今后我们将参照高松塚墓葬的保护方法对这两处洞窟进行科学保护。

来日本之后我还掌握了先进的文物保护与修复体系，即对一个文物在做修复之前，首先要进行调查，从考古、艺术、历史等方面借助肉眼及设备进行调查，通过科学手段了解它的历史、科学价值及制作手法，然后开始制订保护修复计划，最后把劣化环境转变为安定的状态，再进行保存管理。

通过此次学习，我了解到日本对文物保护所采取的手段和使用的材料也是多种多样的，不同的文物采用不同的保护材料和方法。因文物材质的不同和所处的环境的不同导致其劣化呈多样性，这就决定了所需要的文物保护材料的复杂性，也就要求所选材料必须具有针对性。只有选择正确的保护材料才能达到最佳的保护效果，才能最全面地保护历史的痕迹、保护文物各方面的价值。掌握了如何面对品种繁多的材料，依据文物材质、病害状况、所处环境及所需重点保护的文物价值选择出正确的保护材料。懂得了文物保护材料的选择是文物保护处理中十分重要的部分，它直接影响保护处理的结果。正如每一个病人都有针对其病情的药方一样，每一件文物也都有针对其病害的保护材料。就象高妻先生所说：我们是医生，文物是病人，我们的工作是医生的工作，要根据文物的病状诊断病因，根据个体条件对症下药。因此，在保护工作中应全面考虑文物价值、文物材质、病害类别、病害机理、病害产生原因、环境因素、保护材料的性质及适用性等各方面的因素，综合权衡、慎重选择。回国之后，我会将这一理念运用于今后的文物保护工作之中，并加强新疆文物保护工作者与奈良文化财研究所的合作，充分利用奈文研所开发研制的各种保护材料，使新疆的文物保护工作更加科学化。

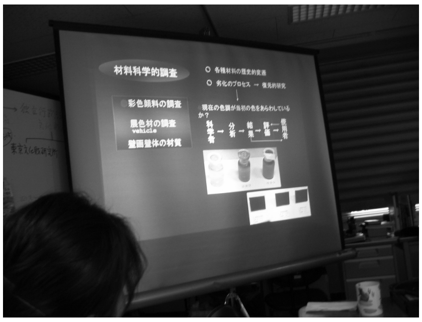
8、与其它国家的研修人员在一起

9、学习野外危急文物的保护

10、学习野外危急文物的搬运

11、肥塚先生授课

此次来日本学习，我不仅了解了日本用于文物保护方面的各种设备的性能，也掌握了一定的修复手段，同时，还学到了日本在文物修复之后的各种保管方法以及在奈良大学西山要一老师的指导下掌握了对野外文物的环境监测方法。懂得了文物因材质的不同，对环境的要求也不同。如果不注重后期的保管工作，可能会对文物造成再一次损坏。而对于野外文物则应采取大气环境的监测，以观察大气温湿度及各种污染元素对文物本体的破坏，从而得到解



12、学习材料分析方法

决的办法。这一方法对新疆的文物保护工作非常有益。在新疆克孜尔千佛周围有一家炼铁厂，长期以来排出来的废气对千佛洞的壁画影响很大，但是因为我们没有进行过大气环境的监测工作，文物部门拿不出环境对壁画造成危害的科学依据来，因而没有办法制止。通过这次学习，我知道了大气污染对文物危害的严重性，掌握了大气中不同的物质对木质文物、石质文物、金属文物的损坏过程，懂得了环境监测的重要性。今后，我们也将积极开展文化遗产的环境监测工作，为政府部门的决策提供科学依据。

通过此次学习，使我不仅了解目前世界先进的文物保存技术和手段，同时也学到了日本在文物保存方面的科学理念及研究体系，解决了我在平时工作中的很多问题，比如，壁画保护问题、特别是墓葬、石窟壁画的现场保护问题，室外文物的现场保护问题，木造建筑、石造建筑及古遗址的保护问题等等。使我们今后在文物的研究和保护技术上更加科学化，更多地研究文物本身的特性及其自身和外界环境作用下不断劣化损坏的机制，从而能够更科学地进行文物的保护和修复；更重视对保护材料、工艺、方法的科学筛选和评价，特别是尽量采用综合治理的办法。总之，此次来日本学到了很多新知识、新观念，这对我今后从事文物保存工作是非常有意义的，同时在日本期间我还结识了许多日本从事文物保护工作的专家学者，回国之后我将积极促进新疆文物工作者与这些专家学者的广泛交流与合作。共同承担对人类文物遗产的保护工作。

感谢联合国亚洲文化中心、感谢奈良文化财研究所、感谢西村康先生、泽田正昭先生、石井香代子女士、松井敏也先生、肥塚隆保先生、高妻洋成先生、降幡顺子女士、西山要一先生及所有的授课老师！

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